Scilab Textbook Companion for Applied Physics-ii by Dr. I. A. Shaikh[1]

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Book Description

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

Contents

List of Scilab Codes

Chapter 1

Interference

Scilab code Exa 1.1 `Find thickness of film`

```
//Chapter-1,Example 1_1,Page 1-16
clc()

//Given Data:
i=45*%pi/180          //angle of incidence
u=1.33                //Refractive index of a soap film
lam=5.896*10^-7       //wavelength of required yellow light

//Calculations:
//u=sin i/sin r       //Snell's law .So,
r=asin(sin(i)/u)      //angle of reflection

//Now, condition for bright fringe is
//2ut*cos r=(2n-1)lam/2
//Here n=1
t=lam/(2*2*u*cos(r))      //minimum thickness of film at which light will appear bright yellow
printf('Minimum thickness of film at which light will appear bright yellow of required wavelength
```

```
    is =%.10f m',t)
```

Scilab code Exa 1.2 Calculate wavelength

```
//Chapter-1,Example 1_2,Page 1-16
clc()

//Given Data:
theta=40/3600*%pi/180      //angle of wedge in
    radians
B=0.12*10^-2               //fringe spacing

//Calculations:
//We know, B=lam/(2*u*theta). Here u=1
lam=2*B*theta              //wavelength of light used
printf('Wavelength of light used is =%.10f m',lam)
```

Scilab code Exa 1.3 Find thickness of film

```
//Chapter-1,Example 1_3,Page 1-17
clc()

//Given Data:
i=30*%pi/180          //angle of incidence
u=1.46                //Refractive index of a oil
lam=5.890*10^-7       //wavelength of required yellow
     light
n=8                   //eighth dark band

//Calculations:
//u=sin i/sin r       //Snell's law   .So,
r=asin(sin(i)/u)      //angle of reflection

```

```
//Now, condition for dark fringe is
//2ut*cos r=n*lam
t=n*lam/(2*u*cos(r))        //thickness of film
printf('Thickness of the film is =%.10f m',t)
```

Scilab code Exa 1.4 Find angle of wedge

```
//Chapter-1,Example 1_4,Page 1-17
clc()

//Given Data:

B=0.1*10^-2                    //fringe spacing
lam=5.893*10^-7                //Wavelength of light
u=1.52                         //Refractive index of
    wedge

//Calculations:
//We know, B=lam/(2*u*theta). Here u=1
theta1=lam/(2*u*B)              //angle of wedge in
    radians
theta=theta1*3600*180/%pi       //angle of wedge in
    seconds
printf('Angle of wedge is =%.0f seconds of an arc',
    theta)
```

Scilab code Exa 1.5 Find refractive index

```
//Chapter-1,Example 1_5,Page 1-18
clc()

//Given Data:
t=0.2/(100)^2*10^-2    //thickness of film in meter
```

```
lam=5.5*10^-7          //wavelength of light in meter
r=0                    //normal incidence
n=1                    //first band

//Calculations:

//Condition for dark fringe is
//2ut*cos r =n*lam
u=n*lam/(2*t*cos(r))   //Refractive index of a oil
printf('Refractive index of a oil is =%.3f ',u)
```

Scilab code Exa 1.6 `Calculate thickness`

```
//Chapter-1,Example 1_6,Page 1-18
clc()

//Given Data:
lam=5.893*10^-7        //Wavelength of light
u=1.42                 //Refractive index of a soap film
r=0                    //normal incidence
n=1                    //first band

//Calculations:

//i)
//Condition for dark fringe is
//2ut*cos r=n*lam
t1=n*lam/(2*u*cos(r))      //thickness of film for dark black fringe
printf('Thickness of the film for dark black fringe is =%.10f m \n \n',t1)

//ii)
//Now, condition for bright fringe is
```

```
//2ut*cos r=(2n-1)lam/2
t2=lam/(2*2*u*cos(r))        //Thickness of film for
    bright fringe
printf(' Thickness of film for bright fringe is =%
    .10f m \n \n',t2)
```

Scilab code Exa 1.7 Calculate thickness

```
//Chapter-1,Example 1_7,Page 1-19
clc()

//Given Data:
i=30*%pi/180            //angle of incidence
u=1.43                  //Refractive index of a soap
    film
lam=6*10^-7             //wavelength of light
n=1                     //For minimum thickness

//Calculations:
//u=sin i/sin r         //Snell's law   .So,
r=asin(sin(i)/u)        //angle of reflection

//Now, condition of minima in transmitted system is
//2ut*cos r=(2n-1)lam/2
t=lam/(2*2*u*cos(r))       //minimum thickness of
    film
printf('Minimum thickness of film is =%.9f m',t)
```

Scilab code Exa 1.8 Calculate thickness

```
//Chapter-1,Example 1_8,Page 1-19
clc()

```

```
//Given Data:
lam=5.893*10^-7          //Wavelength of light
theta=1                  //assuming value of theta

//We know, B=lam/(2*u*theta). Here u=1
B=lam/(2*theta)          //fringe spacing
n=20                     //interference fringes

//Calculations:
//t=n*B*tan(theta)
t=20*B*theta             //Thickness of wire
printf('Thickness of wire is =%.9f m',t)
```

Scilab code Exa 1.9 Calculate thickness

```
//Chapter-1,Example 1_9,Page 1-20
clc()

//Given Data:
u1=1.3              //Refractive index of oil
u2=1.5              //Refractive index of glass
lam1=7*10^-7        //Wavelength of light
lam2=5*10^-7        //Wavelength of light

//Calculations:

//for finding value of n, solve:
//(2n+1)*lam1/2=(2(n+1)+1)*lam2/2
//We get,n=2
n=2

toil=(2*n+1)*lam1/(2*u1*2)      //thickness of oil
    layer
printf('Thickness of oil layer is =%.9f m',toil)
```

Scilab code Exa 1.10 Calculate thickness

```
//Chapter-1,Example 1_10,Page 1-21
clc()

//Given Data:
u1=1.2                     //Refractive index of drop of oil
u2=1.33                    //Refractive index of water
lam=4.8*10^-7              //wavelength of light
n=3                        //order
r=0                        //normal incidence,so r=0

//Calculations:
t=n*lam/(2*u1)              //Thickness of oil drop
printf('Thickness of oil drop is =%.8f m',t)
```

Scilab code Exa 1.11 Calculate thickness

```
//Chapter-1,Example 1_11,Page 1-22
clc()

//Given Data:
i=asin(4/5)                //angle of incidence
u=4/3                      //Refractive index of a soap film
lam1=6.1*10^-7             //wavelength of light
lam2=6*10^-7               //wavelength of light

//Calculations:
//u=sin i/sin r            //Snell's law   .So,
r=asin(sin(i)/u)           //angle of reflection
```

```

//Now, condition for dark band is
//2ut*cos r=n*lam
//for consecutive bands, n=lam2/(lam1-lam2). hence

t=lam2*lam1/((lam1-lam2)*2*u*sqrt(1-(sin(i)/u)^2))
      //thickness of film
printf('Thickness of the film is =%.7f m',t)
```

Scilab code Exa 1.12 Calculate thickness of film

```
//Chapter-1,Example 1_12,Page 1-40
clc()

//Given Data:
n=10                //10th dark ring
Dn=0.5*10^-2        //Diameter of ring
lam=6*10^-7         //wavelength of light

//Calculations:
//As Dn^2=4*n*R*lam
R=Dn^2/(4*n*lam)    //Radius of curvature of the
   lens
printf('Radius of curvature of the lens is =%.2f m \
   n \n',R)

t=Dn^2/(8*R)        //thickness of air  film
printf(' Thickness of air  film is =%.7f m \n',t)
```

Scilab code Exa 1.13 Calculate angle of wedge

```
//Chapter-1,Example 1_13,Page 1-41
clc()
```

```

//Given Data:

B=0.25*10^-2                //fringe spacing
lam=5.5*10^-7               //Wavelength of light
u=1.4                       //Refractive index of wedge

//Calculations:
//We know, B=lam/(2*u*theta).
theta1=lam/(2*u*B)             //angle of wedge in
    radians
theta=theta1*3600*180/%pi    //angle of wedge in
    seconds
printf('Angle of wedge is =%.1f seconds',theta)
```

Scilab code Exa 1.14 Find diameter of ring

```
//Chapter-1,Example 1_14,Page 1-41
clc()

//Given Data:
n=4                 //4th dark ring
m=12                //m=n+p
D4=0.4*10^-2        //Diameter of 4th ring
D12=0.7*10^-2       //Diameter of 12th ring

//Calculations:

//(Dn+p)^2-Dn^2=4*p*lam*R
//Solving, (D12^2-D4^2)/(D20^2-D4^2)
//We get above value =1/2. Hence
D20=sqrt(2*D12^2-D4^2)        //Diameter of 20th ring
printf('Diameter of 20th ring is =%.5f m \n',D20)
```

Scilab code Exa 1.15 Calculate refractive index

```
//Chapter-1,Example 1_15,Page 1-42
clc()

//Given Data:
n=6                 //6th bright ring
D6=0.31*10^-2       //Diameter of 6th ring
lam=6*10^-7         //wavelength of light
R=1                 //Radius of curvature

//Calculations:

//Diameter of nth bright ring is
//Dn^2=2(2n-1)*lam*R/u. Hence
u=2*(2*n-1)*lam*R/(D6)^2     //Refractive index of
   liquid
printf('Refractive index of liquid is =%.3f \n',u)
```

Scilab code Exa 1.16 Find difference of squares of diameters of rings

```
//Chapter-1,Example 1_16,Page 1-42
clc()

//Given Data:
lam=6*10^-7          //wavelength of light
k=0.125*10^-4        //k=D(n+1)^2-Dn^2.
u=1                  //Refractive index of medium
   between lens and plate
//Calculations:

//i)
```

```
lam1=4.5*10^-7    //new wavelength of light
//Difference between squres of diameters of successive rings is directly proportional to wavelength.So,
k1=lam1/lam*k    //new Difference between squres of diameters of successive rings after changing wavelength
printf('New Difference between squres of diameters of successive rings after changing wavelength is =%.8f m^2 \n',k1)

//ii)
u2=1.33              //Refractive index of liquid introduced between lens and plate
//Difference between squres of diameters of successive rings is inversely proportional to Refractive index.so,
k2=u/u2*k            //new Difference between squres of diameters of successive rings after changing refractive index
printf(' New Difference between squres of diameters of successive rings after changing refrective index is =%.8f m^2 \n',k2)

//iii)
//Difference between squres of diameters of successive rings is directly proportional to Radius of curvature.So,
//after doubling radius of curvature,
k3=2*k               //new Difference between squres of diameters of successive rings after doubling radius of curvature
printf(' New Difference between squres of diameters of successive rings after doubling radius of curvature is =%.8f m^2 \n',k3)
```

Scilab code Exa 1.17 Calculate Refractive index

```
//Chapter-1,Example 1_17,Page 1-43
clc()

//Given Data:
Dn=0.225*10^-2          //Diameter of nth ring
Dm=0.45*10^-2           //Diameter of (n+9)th ring
lam=6*10^-7             //wavelength of light
R=0.9                   //Radius of curvature
p=9

//Calculations:
//(Dn+p)^2-Dn^2=4*p*lam*R/u
u=4*p*lam*R/((Dm)^2-Dn^2)     //Refractive index of
    liquid
printf('Refractive index of liquid is =%.2f \n',u)
```

Scilab code Exa 1.18 Find diameter of ring

```
//Chapter-1,Example 1_18,Page 1-44
clc()

//Given Data:
D10=0.5*10^-2           //Diameter of 10th ring
lam=5.5*10^-7           //wavelength of light
u=1.25                  //Refractive index of liquid


//Calculations:
//As Dn^2=4*n*R*lam/u
```

```
//Dn^2 is inversely proportional to refractive index
   .
D10n=D10/sqrt(u)          //new diameter of 10th
   ring after changing medium between lens and plate
printf('new diameter of 10th ring after changing
   medium between lens and plate is =%.6f m \n',D10n
   )
```

Scilab code Exa 1.19 Find radius of curvature

```
//Chapter-1,Example 1_19,Page 1-45
clc()

//Given Data:
D5=0.336*10^-2          //Diameter of 5th ring
D15=0.59*10^-2          //Diameter of 15th ring
lam=5.89*10^-7          //wavelength of light
p=10                    //n=5,n+p=15

//Calculations:
//(Dn+p)^2-Dn^2=4*p*lam*R/u
R=((D15)^2-D5^2)/(4*p*lam)     //Radius of curvature
   of the lens
printf('Radius of curvature of the lens is =%.3f m \
   n',R)
```

Scilab code Exa 1.20 Find radius of curvature

```
//Chapter-1,Example 1_20,Page 1-45
clc()

//Given Data:
n=10                  //10th dark ring
```

```
D10=0.6*10^-2       //Diameter of ring
lam=6*10^-7         //wavelength of light
u=4/3               //Refractive index of water


//Calculations:
//As Dn^2=4*n*R*lam/u
R=D10^2*u/(4*n*lam)     //Radius of curvature of the
    lens
printf('Radius of curvature of the lens is =%.1f m \
    n',R)
```

Scilab code Exa 1.20.1 `Find wavelength`

```
//Chapter-1,Example 1_20_1,Page 1-52
clc()

//Given Data:
i=45*%pi/180            //angle of incidence
u=1.2                   //Refractive index of a film
t=4*10^-7               //thickness of film

//Calculations:
//u=sin i/sin r         //Snell's law    .So,
r=asin(sin(i)/u)        //angle of reflection

//Now, condition for dark fringe is
//2ut*cos r=n*lam
lam1=2*u*t*cos(r)/1             //n=1
printf('For n=1 wavelength is =%.10f m \n',lam1)
printf(' This is in the visible spectrum and it will
     remain absent.\n \n')

lam2=2*u*t*cos(r)/2             //n=2
printf(' For n=2 wavelength is =%.10f m \n',lam2)
```

```
printf(' This is not in the visible spectrum \n \n')
```

Scilab code Exa 1.20.2 Find thickness of medium

```
//Chapter-1,Example 1_20_2,Page 1-53
clc()

//Given Data:
r=45*%pi/180            //angle of refraction
u=1.45                  //Refractive index of a medium
lam=5.5*10^-7           //wavelength of required yellow
    light
n=1

//Calculations:

//Now, condition for dark fringe is
//2ut*cos r=n*lam
t=n*lam/(2*u*cos(r))        //thickness of thin medium
printf('Thickness of the thin medium is =%.10f m',t)
```

Scilab code Exa 1.21 Find wavelength

```
//Chapter-1,Example 1_21,Page 1-45
clc()

//Given Data:
u=1.33                    //Refractive index of a soap
   film
r=0                       //normal incidence
t=5*10^-7                 //thickness of film

//Calculations:
```

```

//Now, condition for maxima is
//2ut*cos r=(2n-1)lam/2
lam1=4*u*t*cos(r)/(2*1-1)            //n=1
printf('For n=1 wavelength is =%.10f m \n',lam1)
lam2=4*u*t*cos(r)/(2*2-1)            //n=2
printf(' For n=2 wavelength is =%.10f m \n',lam2)
lam3=4*u*t*cos(r)/(2*3-1)            //n=3
printf(' For n=3 wavelength is =%.10f m \n',lam3)
lam4=4*u*t*cos(r)/(2*4-1)            //n=4
printf(' For n=4 wavelength is =%.10f m \n \n',lam4)

printf(' Out of these wavelengths wavelength for n=3 lies in the visible spectrum. \n \n')
printf(' Hence, wavelength for n=3 is the most reflected wavelength.')
```

Scilab code Exa 1.22 Calculate thickness

```
//Chapter-1,Example 1_22,Page 1-46
clc()

//Given Data:
u=1.5                  //Refractive index of a oil
lam=5.88*10^-7         //wavelength of required yellow light
n=1                    //for smallest thickness
r=60*%pi/180           //angle of reflection

//Calculations:

//Now, condition for dark fringe is
//2ut*cos r=n*lam
t=n*lam/(2*u*cos(r))        //thickness of film
printf('Thickness of the film is =%.10f m',t)
```

Scilab code Exa 1.23 Calculate wavelength

```
//Chapter-1,Example 1_23,Page 1-46
clc()

//Given Data:
theta=20/3600*%pi/180      //angle of wedge in
   radians
B=0.25*10^-2               //fringe spacing
u=1.4                      //Refractive index of film

//Calculations:
//We know, B=lam/(2*u*theta).
lam=2*B*theta*u                //wavelength of light
printf('Wavelength of light is =%.10f m',lam)
```

Scilab code Exa 1.24 Find order of ring

```
//Chapter-1,Example 1_24,Page 1-47
clc()

//Given Data:
//Dn=2*D40

//Calculations:
//As Dn^2=4*n*R*lam/u and Dn^2=4*D40^2
//i.e. 4*n*R*lam/u=4*4*40*R*lam/u .hence,
n=4*40            //order of the required ring
printf('Order of the dark ring which will have
   double the diameter of that of 40th ring is =%.0f
    ',n)
```

Scilab code Exa 1.25 Calculate diameter of ring

```
//Chapter-1,Example 1_25,Page 1-47
clc()

//Given Data:
lam1=6*10^-7       //wavelength of light
lam2=4.5*10^-7     //wavelength of light
R=0.9              //Radius of curvature

//Calculations:
//As Dn^2=4*n*R*lam.
//Dn^2=D(n+1)^2 for different wavelengths.we get,
n=lam2/(lam1-lam2)     //nth dark ring due to lam1
    which coincides with (n+1)th dark ring due lam2
D3=sqrt(4*n*R*lam1)    //diameter of 3rd dark ring
    for lam1
printf('Diameter of 3rd dark ring for lam1 is =%.5f
    m \n',D3)
```

Scilab code Exa 1.26 Calculate order of band

```
//Chapter-1,Example 1_26,Page 1-48
clc()

//Given Data:
i=45*%pi/180          //angle of incidence
u=4/3                 //Refractive index of soap film
lam=5*10^-7           //wavelength of light
t=1.5*10^-6           //thickness of film

//Calculations:
```

```
//u=sin i/sin r       //Snell's law   .So,
r=asin(sin(i)/u)      //angle of reflection

//Now, condition for dark band is
//2ut*cos r=n*lam
n=2*u*t*cos(r)/lam    //order of band
printf('order of dark band is =%.1f \n',n)
```

Scilab code Exa 1.27 Find radius of curvature

```
//Chapter-1,Example 1_27,Page 1-49
clc()

//Given Data:
D5=0.336*10^-2          //Diameter of 5th ring
D15=0.59*10^-2          //Diameter of 15th ring
lam=5.89*10^-7          //wavelength of light
p=10                    //n=5,n+p=15

//Calculations:
//(Dn+p)^2-Dn^2=4*p*lam*R/u
R=((D15)^2-D5^2)/(4*p*lam)     //Radius of curvature of the lens
printf('Radius of curvature of the lens is =%.4f m \n',R)
```

Scilab code Exa 1.29 Prove separation between consecutive rings reduces as serial

```
//Chapter-1,Example 1_29,Page 1-50
clc()

//As Dn^2=4*n*R*lam.
```

```
//thus, Dn is directly proportional to sqaure root of n
D5=sqrt(5)      //D5 is directly proportional to sqaure root of 5
D4=sqrt(4)      //D4 is directly proportional to sqaure root of 4
k1=D5-D4
printf('Separation between D5 and D4 is directly proportional to =%.3f \n',k1)

D80=sqrt(80)      //D80 is directly proportional to sqaure root of 80
D79=sqrt(79)      //D79 is directly proportional to sqaure root of 79
k2=D80-D79
printf(' Separation between D80 and D79 is directly proportional to =%.3f \n \n',k2)

printf(' Thus, (D80-D79) < (D5-D4).\n Hence proved.')
```

Scilab code Exa 1.30 `Calculate wavelength`

```
//Chapter-1,Example 1_30,Page 1-51
clc()

//Given Data:
D5=0.336*10^-2          //Diameter of 5th ring
D15=0.59*10^-2          //Diameter of 15th ring
p=10                    //n=5,n+p=15
R=1                     //Radius of curvature

//Calculations:
//(Dn+p)^2-Dn^2=4*p*lam*R/u
lam=((D15)^2-D5^2)/(4*p*R)     //Wavelength of light
```

```
printf('Wavelength of light is =%.10f m',lam)
```

Scilab code Exa 1.31 `Obtain expression for thickness of film`

```
//Chapter-1,Example 1_31,Page 1-51
clc()


//Condition for bright band is
//2ut*cos r = (2n-1)*lam1

//for consecutive bands, 2n=(lam1+lam2)/(lam1-lam2).
//thus, 2ut*cos r = lam2*lam1/(lam1-lam2)

//And, thicknessof film
//t= lam2*lam1/((2*u*cosr)(lam1-lam2))
printf('Hence expression for thickness of film is
    obtained.')
```

Chapter 2

Diffraction of light

Scilab code Exa 2.1 Find longest wavelength

```
//Chapter-2,Example 2_1,Page 2-30
clc()

//Given Data:
m=4          //order
N=1/5000*10^-2     //N=(a+b) grating element

//Calculations:

//We know, (a+b)*sin(theta)=m*lam
//for longest wavelength, sin(theta)=1
lam=N/m       //longest wavelength
printf('The longest wavelength is =%.10f m',lam)
```

Scilab code Exa 2.2 Calculate width of slit

```
//Chapter-2,Example 2_2,Page 2-30
clc()
```

```

//Given Data:
m=1                 //order
lam=6.5*10^-7       //Wavelength of red light
theta=30*%pi/180    //angle of diffraction

//Calculations:

//We know, a*sin(theta)=m*lam
a=m*lam/sin(theta)    //width of slit
printf('width of slit is = %.7f m',a)
```

Scilab code Exa 2.3 Calculate angular position of first minima

```
//Chapter-2,Example 2_3,Page 2-31
clc()

//Given Data:
m=1                 //order
lam=4*10^-7         //Wavelength of light
a=10^-6             //width of slit

//Calculations:

//We know, a*sin(theta)=m*lam
theta=asin(m*lam/a)*180/%pi     //angular position in first minima
printf('angular position in first minima is = %.2f degrees',theta)
```

Scilab code Exa 2.4 Find angular breadth

```
//Chapter-2,Example 2_4,Page 2-31
```

```
clc()

//Given Data:
m=1                   //order
lam1=4*10^-7          //Wavelength of light
lam2=7*10^-7          //Wavelength of light
n=1/6000*10^-2        //n=(a+b) grating element

//Calculations:

//We know, (a+b)*sin(theta)=m*lam
theta1=asin(m*lam1/n)*180/%pi     //angle of
    diffraction
theta2=asin(m*lam2/n)*180/%pi     //angle of
    diffraction
d=theta2-theta1                   //angular breadth
    of first order visible spectrum
printf('angular breadth of first order visible
    spectrum is = %.2f degrees',d)
```

Scilab code Exa 2.5 Calculate total number of lines on grating

```
//Chapter-2,Example 2_5,Page 2-31
clc()

//Given Data:
m=1                      //order
lam=6.56*10^-7           //Wavelength of red light
theta=18.25*%pi/180      //angle of diffraction
W=2*10^-2                //width of grating

//Calculations:

//We know, (a+b)*sin(theta)=m*lam
N=sin(theta)/(m*lam)     //N-number of lines per m, N
```

```
=1/(a+b)
Tn=N*W                    //Total number of lines on grating
printf('Total number of lines on grating is = %.0f ',Tn)
```

Scilab code Exa 2.7 Show that spectra either overlap or are isolated

```
//Chapter-2,Example 2_7,Page 2-33
clc()

//Given Data:
GE=2.54/15000*10^-2       //GE=(a+b) grating element
lam1=4*10^-7              //Wavelength of light
lam2=7*10^-7              //Wavelength of light

//Calculations:

//We know, (a+b)*sin(theta)=m*lam
theta11=asin(1*lam1/GE)*180/%pi        //angular position of first minima for lam1
theta12=asin(2*lam1/GE)*180/%pi        //angular position of second minima for lam1
theta13=asin(3*lam1/GE)*180/%pi        //angular position of third minima for lam1

theta21=asin(1*lam2/GE)*180/%pi        //angular position of first minima for lam2
theta22=asin(2*lam2/GE)*180/%pi        //angular position of second minima for lam2
theta23=asin(3*lam2/GE)*180/%pi        //angular position of third minima for lam2

printf('Thus the angular position for lam1 and lam2 are as follows: \n \n ')
```

```
printf('First order: %.0f degrees',theta11)
printf(' %.0f degrees --Isolated \n',theta21)

printf(' Second order: %.0f degrees',theta12)
printf(' %.0f degrees --Overlap \n',theta22)

printf(' Third order: %.0f degrees',theta13)
printf(' %.0f degrees --Overlap \n',theta23)
```

Scilab code Exa 2.8 Calculate separation between central maxima and first minima

```
//Chapter-2,Example 2_8,Page 2-34
clc()

//Given Data:
lam=5.893*10^-7          //Wavelength of light
d=0.01*10^-2             //width of slit (a=d)
f=1                      //distance between screen and slit

//Calculations:
x=f*lam/d                //separation between central maxima and first minima
printf('Separation between central maxima and first minima is = %.6f m \n',x)
```

Scilab code Exa 2.9 Find angular width

```
//Chapter-2,Example 2_9,Page 2-34
clc()

//Given Data:
m=1                    //order
```

```
lam=6*10^-7           //Wavelength of light
a=12*10^-7            //width of slit

//Calculations:

//We know, a*sin(theta)=m*lam
theta=asin(m*lam/a)*180/%pi     //angular position in
    first minima
printf('Half angular width of first maxima is = %.0f
    degrees',theta)
```

Scilab code Exa 2.10 `Calculate total angular width`

```
//Chapter-2,Example 2_10,Page 2-34
clc()

//Given Data:
lam=6*10^-7               //Wavelength of light
a=0.02*10^-2              //width of slit (a=d)
f=2                       //distance between screen and
    slit

//Calculations:

//We know, a*sin(theta)=m*lam, here m=1
theta=asin(lam/a)*180*60/%pi       //angular position
    in first minima (1 degree=60 minutes)
printf('Total angular width is = %.2f minutes \n \n'
   ,2*theta)

x=f*lam/a                 //separation between central
   maxima and first minima
printf(' Linear width is = %.6f m \n',2*x)
```

Scilab code Exa 2.11 `Find wavelength`

```
//Chapter-2,Example 2_11,Page 2-35
clc()

//Given Data:
a=0.14*10^-3          //width of slit
n=2                   //order
y=1.6*10^-2           //separation between second dark band and central bright band
D=2                   //distance between screen and slit

//Calculations:

theta=y/D             //from diagram

//We know, a*sin(theta)=n*lam
//here sin(theta)=theta
lam=a*theta/n         //wavelength of light
printf('wavelength of light is = %.10f m \n',lam)
```

Scilab code Exa 2.13 `Find angles of maxima`

```
//Chapter-2,Example 2_13,Page 2-36
clc()

//Given Data:
lam=6.328*10^-7          //Wavelength of light
N=1/6000*10^-2           //N=(a+b) grating element

//Calculations:
```

```

//We know, N*sin(theta)=m*lam
theta1=asin(1*lam/N)*180/%pi     //angular position in first order maxima,m=1
printf('Angular position in first order maxima is = %.2f degrees \n \n',theta1)

theta2=asin(2*lam/N)*180/%pi     //angular position in second order maxima,m=2
printf(' Angular position in second order maxima is = %.2f degrees \n',theta2)
```

Scilab code Exa 2.14 `Calculate grating element`

```
//Chapter-2,Example 2_14,Page 2-37
clc()

//Given Data:
lam1=6*10^-7          //wavelength of yellow light
lam2=4.8*10^-7        //wavelength of blue light
theta=asin(3/4)       //angle of diffraction

//Calculations:

//for consecutive bands, n*lam1=(n+1)*lam2. thus,
n=lam2/(lam1-lam2)    //order

//We know, (a+b)*sin(theta)=m*lam
N=n*lam1/sin(theta)    //N=(a+b) grating element
printf('Grating element (a+b) is = %.8f m \n',N)
```

Scilab code Exa 2.15.1 `Compute wavelength`

```
//Chapter-2,Example 2_15_1,Page 2-54
clc()

//Given Data:
a=0.2*10^-3              //width of slit
n=1                      //order
y=0.5*10^-2              //separation between first
   minima and central bright band
D=2                      //distance between screen and
   slit

//Calculations:

theta=y/D                //from diagram

//We know, a*sin(theta)=n*lam
//here sin(theta)=theta
lam=a*theta/n            //wavelength of light
printf('wavelength of light is = %.10f m \n',lam)
```

Scilab code Exa 2.15.2 `Find number of lines per cm`

```
//Chapter-2,Example 2_15_2,Page 2-55
clc()

//Given Data:
lam1=5.4*10^-7                //Wavelength of light
lam2=4.05*10^-7               //Wavelength of light
theta=30*%pi/180              //angle of diffraction

//Calculations:
//We know, (a+b)*sin(theta)=n*lam
//n*lam1=(n+1)*lam2, we get
n=3
N=sin(theta)/(n*lam1)*10^-2      //Number of lines
```

```
per m= 1/(a+b)*10^-2
printf('Number of lines per cm is = %.0f \n',N)
```

Scilab code Exa 2.15.4 Check whether lines are resolved or not

```
//Chapter-2,Example 2_15_4 ,Page 2-56
clc()

//Given Data:
GE=1/6000*10^-2                //GE=(a+b) grating element
lam1=5.893*10^-7               //Wavelength of light
lam2=5.896*10^-7               //Wavelength of light
m=2                            //order

//Calculations:
theta1=asin(m*lam1/GE)*180/%pi       //angular position in first minima
theta2=asin(m*lam2/GE)*180/%pi       //angular position in second minima

as=(theta2-theta1)             //Angular separation in minutes
printf('Angular separation is = %.3f degrees \n \n',as)

dlam=lam2-lam1                 //difference in wavelength
lam=(lam2+lam1)/2              //Mean wavelength

//We know that R.P.=lam/dlam=m*N
N=lam/dlam/m                   //Number of lines on grating for first order
printf(' Number of lines on grating for first order is = %.0f  \n \n',N)
```

```
printf(' But, number of lines per cm on grating is 6000. \n Which is greater than number of lines per cm needed for resolution. \n')
printf(' Hence, both lines will be well resolved in 2nd order.')
```

Scilab code Exa 2.17 Calculate wavelength and deduce missing order

```
//Chapter-2,Example 2_17,Pad 2-39
clc()

//Given Data:
d=0.04*10^-2          //Separation between slits
D=1.7                 //distance between screen and slit
B=0.25*10^-2          //Fringe spacing

//Calculations:
//We know,B=D*lam/d
lam=B*d/D             //Wavelength of light
printf('Wavelength of light is = %.10f m \n \n',lam)

//The condition for missing order is,
//(a+b)/a = m/n
b=0.04*10^-2          //Separation in slits
a=0.08*10^-3          //Slit width
n=(a+b)/a             //missing orders for m=1,2,3

n1=1*n
n2=2*n
n3=3*n
printf(' Missing orders are = %.0f',n1)
printf(', %.0f',n2)
printf(', %.0f',n3)
```

Scilab code Exa 2.18 Find maximum order visible

```
//Chapter-2,Example 2_18,Page 2-39
clc()

//Given Data:
N=2.54/2620*10^-2      //N=(a+b) grating element
lam=5*10^-7            //Wavelength of red light

//Calculations:

//We know, (a+b)*sin(theta)=n*lam
//maximum value of sin(theta)=1
n=N/lam                //Maximum number of orders
    visible
printf('Maximum number of orders visible is = %.0f '
    ,n)
```

Scilab code Exa 2.19 Find number of orders visible

```
//Chapter-2,Example 2_19,Page 2-40
clc()

//Given Data:
N=1/4000*10^-2        //N=(a+b) grating element
lam1=5*10^-7          //Wavelength of light
lam2=7.5*10^-7        //Wavelength of light

//Calculations:

//We know, (a+b)*sin(theta)=n*lam
//maximum value of sin(theta)=1
```

```
n1=N/lam1                    //Maximum number of orders visible
n2=N/lam2                    //Maximum number of orders visible
printf('The observed number of orders range between = %.0f  ',n2)
printf('to %.0f',n1)
```

Scilab code Exa 2.20 `Find wavelength that coincides`

```
//Chapter-2,Example 2_20 ,Page 2-40
clc()

//Given Data:
n=5                    //order
lam=6*10^-7            //Wavelength of light

//Calculations:
//We know, a*sin(theta)=n*lam
//n*lam=n1*lam1
lam1=n*lam/4           //for n1=4
printf('For n1=4 wavelength is = %.10f \n',lam1)

lam2=n*lam/5           //for n1=5
printf(' For n1=5 wavelength is = %.10f \n',lam2)

lam3=n*lam/6           //for n1=6
printf(' For n1=6 wavelength is = %.10f \n',lam3)

lam4=n*lam/7           //for n1=7
printf(' For n1=7 wavelength is = %.10f \n',lam4)

lam5=n*lam/8           //for n1=8
printf(' For n1=8 wavelength is = %.10f \n',lam5)

```

```
printf('So,in the grating spectrum spectrum lines
    with wavelengths n1=6 and n1=7 will coincide with
     fifth order line of 6*10^-7 m')
```

Scilab code Exa 2.21 Calculate Dispersive power

```
//Chapter-2,Example 2_21,Page 2-41
clc()

//Given Data:
GE=18000*10^-10              //GE=(a+b) grating element
lam=5*10^-7                  //Wavelength of red light

//Calculations:
DP1=1/sqrt(GE^2-lam^2)*10^-10         //Dispersive
    power
printf('Dispersive power for first order is = %.10f
    rad/Angstrom  \n \n',DP1)

m=3
DP2=1/sqrt((GE/m)^2-lam^2)*10^-10     //Dispersive
    power
printf(' Dispersive power for second order is = %.10
    f rad/Angstrom  \n \n',DP2)
```

Scilab code Exa 2.22 Find linear and angular dispersion

```
//Chapter-2,Example 2_22,Page 2-42
clc()

//Given Data:
N=2.54/15000*10^-2           //N=(a+b) grating element
lam=5.9*10^-7                //Wavelength of light
```

```
m=2                         //order
f=25*10^-2                  //focal length of lens

//Calculations:

//We know, (a+b)*sin(theta)=m*lam
theta=asin(m*lam/N)         //angular position in first
    minima

Ad=m/N/cos(theta)                  //angular dispersion

ld=f*Ad*10^-8                      //linear dispersion (
   dx/dl) in cm/angstrom
printf('Linear dispersion in spectrograph is = %.5f
   cm/angstrom \n \n',ld)

dlam=(5896-5890)                   //difference in
   wavelength
dx=ld*dlam*10^-2                   //separation between
   spectral lines in meter
printf(' Separation between spectral lines is = %.5f
    m \n \n',dx)
```

Scilab code Exa 2.23 Calculate number of lines

```
//Chapter-2,Example 2_23,Page 2-47
clc()

//Given Data:
m=1                               //order
lam1=5.89*10^-7                   //Wavelength of light
lam2=5.896*10^-7                  //Wavelength of light

//Calculations:
dlam=lam2-lam1                    //difference in
```

```
    wavelength
lam=(lam2+lam1)/2                //Mean wavelength

//We know that R.P.=m*N=lam/dlam
N=lam/dlam/m                     //minimum number of
    lines which will just resolve
printf('Minimum number of lines which will just
    resolve is = %.1f  \n \n',N)
```

Scilab code Exa 2.24 Calculate resolving power

```
//Chapter-2,Example 2_24,Page 2-47
clc()

//Given Data:
N=5*5000             //N=W/(a+b) Number of lines on
    grating
m=2                  //order
lam=6*10^-7          //Wavelength of light

//Calculations:
//i)
RP=m*N               //Resolving power
printf('i)Resolving power is = %.0f  \n \n',RP)

//ii)
//We know that R.P.=lam/dlam
dlam=lam/RP          //Smallest wavelength which can
    be resolved
printf(' ii)Smallest wavelength which can be
    resolved is = %.12f m \n \n',dlam)
```

Scilab code Exa 2.25 Calculate Dispersive power

```
//Chapter −2,Example 2_25 ,Page 2−48
clc()

//GiveGE Data:
GE=1/4000*10^-2          //GE=(a+b) grating element
lam=5*10^-7              //Wavelength of red light
m=3                      //order

//Calculations:

//We know, (a+b)*sin(theta)=m*lam
theta=asin(m*lam/GE)      //angular position in first
    minima

DP=m/(GE*cos(theta))*10^-2      //Dispersive power
printf('Dispersive power is = %.0f \n \n',DP)
```

Scilab code Exa 2.26 Calculate grating element

```
//Chapter −2,Example 2_26 ,Page 2−48
clc()

//Given Data:
m=2                   //order
lam=6*10^-7           //Wavelength of light
dlam=6*10^-10         //difference in wavelength
W=2*10^-2             //Width of surface

//Calculations:

//We know that R.P.=lam/dlam=m*N
N=lam/dlam/m         //Number of lines on grating
GE=W/N               //Grating element=(a+b)
printf('Grating element is = %.6f cm \n \n',GE)
```

Scilab code Exa 2.27 Calculate angular separation

```
//Chapter-2,Example 2_27,Page 2-49
clc()

//Given Data:
m=2                             //order
lam1=5.77*10^-7                 //Wavelength of light
lam2=5.791*10^-7                //Wavelength of light
GE=1/6000*10^-2                 //GE=(a+b) grating element

//Calculations:

//We know, (a+b)*sin(theta)=m*lam
theta1=asin(m*lam1/GE)*180/%pi      //angular position in first minima
theta2=asin(m*lam2/GE)*180/%pi      //angular position in second minima

as=(theta2-theta1)*60           //Angular separation in minutes
printf('Angular separation is = %.0f minutes \n \n',as)
```

Scilab code Exa 2.28 Find the angle of first dark band

```
//Chapter-2,Example 2_28,Page 2-49
clc()

//Given Data:
n=1                     //order
```

```
lam=5.89*10^-7          //Wavelength of light
a=0.3*10^-3             //width of slit

//Calculations:

//We know, a*sin(theta)=n*lam
theta1=asin(n*lam/a)*180/%pi*60      //angular
   position in first dark band in minutes
printf('Angular position in first dark band is = %.1
   f minutes \n \n',theta1)

//We know,for bright band   a*sin(theta)=(2n+1)*lam
   /2
theta2=asin(1.5*lam/a)*180/%pi*60     //angular
   position in first bright band in minutes
printf(' Angular position in first bright band is =
   %.0f minutes',theta2)
```

Scilab code Exa 2.29 `Calculate maximum order of spectrum`

```
//Chapter-2,Example 2_29,Page 2-50
clc()

//Given Data:
GE=2.54/16000*10^-2          //GE=(a+b) grating element
lam=6*10^-7                  //Wavelength of light

//Calculations:

//We know, (a+b)*sin(theta)=m*lam
//maximum value of sin(theta)=1
m=GE/lam                     //Maximum order of spectra
printf('Maximum order of spectra is = %.1f \n \n',m)
```

Scilab code Exa 2.30 `Find maximum resolving power`

```
//Chapter-2,Example 2_30,Page 2-50
clc()

//Given Data:
GE=1/5000*10^-2          //GE=(a+b) grating element
lam=5.89*10^-7           //Wavelength of light
N=3*5000                 //N=W/(a+b) Number of lines
    on grating

//Calculations:

//We know, (a+b)*sin(theta)=m*lam
//maximum value of sin(theta)=1
m=GE/lam                 //Maximum order of spectra
printf('Maximum order of spectra is = %.0f \n \n',m)

RP=3*N                   //Resolving power (round of m
    to 3)
printf('Resolving power is = %.0f  \n \n',RP)
```

Scilab code Exa 2.32 `Find number of lines`

```
//Chapter-2,Example 2_32,Page 2-52
clc()

//Given Data:
lam1=5.89*10^-7              //Wavelength of light
lam2=5.896*10^-7             //Wavelength of light

//Calculations:
```

```
dlam=lam2-lam1                    //difference in wavelength
lam=(lam2+lam1)/2                 //Mean wavelength

//i)
m1=1                  //first order
//We know that R.P.=lam/dlam=m*N
N1=lam/dlam/m1        //Number of lines on grating
printf('i)Number of lines on grating for first order is = %.0f \n \n',N1)

//ii)
m2=2                  //second order
//We know that R.P.=lam/dlam=m*N
N2=lam/dlam/m2        //Number of lines on grating
printf(' ii)Number of lines on grating for second order is = %.0f \n \n',N2)
```

Scilab code Exa 2.33 Calculate number of lines

```
//Chapter-2,Example 2-33,Page 2-48
clc()

//Given Data:
m=1                   //order
lam=6.553*10^-7       //Wavelength of light
dlam=1.8*10^-10       //difference in wavelength


//Calculations:

//We know that R.P.=lam/dlam=m*N
N=lam/dlam/m          //Number of lines on grating
printf('Number of lines on grating is = %.0f \n \n',N)
```

Scilab code Exa 2.34 Find resolution possible or not

```
//Chapter-2,Example 2_34 ,Page 2-53
clc()

//Given Data:
lam1=5.14034*10^-7                         //Wavelength of
    light
lam2=5.14085*10^-7                         //Wavelength of
    light

//Calculations:
dlam=lam2-lam1                         //difference in
    wavelength
lam=(lam2+lam1)/2                      //Mean wavelength

//We know that R.P.=lam/dlam=m*N
N=lam/dlam/1          //Number of lines on grating
printf('Number of lines on grating for first order
    is = %.0f  \n \n',N)

//Hence R.P. for second order should be
RP1=2*N
printf(' Resolving power in second order should be
    is= %.0f \n \n',RP1)
//But here,

lam3=8.03720*10^-7                         //Wavelength of
    light
lam4=8.03750*10^-7                         //Wavelength of
    light
dlam2=lam4-lam3                            //difference in
    wavelength
lam2=(lam4+lam3)/2                         //Mean wavelength
```

```
RP2=lam2/dlam2
printf(' Resolving power in second order is= %.0f \n \n',RP2)

printf(' So, the grating will not be able to resolve 8.0372*10^-7 and 8.03750*10^-7 in second order.\n')
printf(' Because Resolving power is greter than actual Resolving power.')
```

Scilab code Exa 2.35 Show that First order spectra is possible

```
//Chapter-2,Example 2_35,Page 2-53
clc()

//For grating , Condition of maxima is (a+b)sin(theta)=n*lam
//Given (a+b) < 2*lam
//For maximum order, sin(90)=1
//So, n must be less than 2
//i.e. only first order possible if width of grating element is less than twice the wavelength
printf('Hence, Only first order possible if width of grating element is less than twice the wavelength.')
```

Scilab code Exa 2.36 Calculate angle of first dark band

```
//Chapter-2,Example 2_36,Page 2-54
clc()

//Given Data:
```

```
n=1                  //order
lam=5.89*10^-7       //Wavelength of light
a=0.3*10^-3          //width of slit

//Calculations:

//We know, a*sin(theta)=n*lam
theta1=asin(n*lam/a)*180/%pi      //angular position
    in first dark band
printf('Angular position in first dark band is = %.3
    f degrees \n \n',theta1)

//We know,for bright band    a*sin(theta)=(2n+1)*lam
    /2
theta2=asin(1.5*lam/a)*180/%pi     //angular position
     in first bright band
printf(' Angular position in first bright band is =
    %.3f degrees',theta2)
```

Chapter 3

Optical Fibre

Scilab code Exa 3.1 Find NA of fibre

```
//Chapter-3,Example 3_1,Page 3-19
clc()

//Given Data:
n1=1.61                  //Core index
n2=1.55                  //Cladding index

//Calculations:
NA=sqrt(n1^2-n2^2)       //Formula

printf('Numerical Aperture of Fibre is = %.3f ',NA)
```

Scilab code Exa 3.2 Find NA of fibre

```
//Chapter-3,Example 3_2,Page 3-19
clc()

//Given Data:
```

```
n1=1.65                    //Core index
n2=1.53                    //Cladding index

//Calculations:
NA=sqrt(n1^2-n2^2)         //Formula

printf('Numerical Aperture of Fibre is = %.3f ',NA)
```

Scilab code Exa 3.3 Find acceptance angle

```
//Chapter-3,Example 3_3,Page 3-19
clc()

//Given Data:
n1=1.48                    //R.I. of Core
n2=1.39                    //R.I. of Cladding

//Calculations:
NA=sqrt(n1^2-n2^2)         //Formula to find NA
phi=asin(NA)*180/%pi       //Acceptance angle

printf('Numerical Aperture of Fibre is = %.3f \n \n'
    ,NA)
printf(' Acceptance angle of Fibre is =%.1f degrees'
    ,phi)
```

Scilab code Exa 3.4 Find velocity and wavelengths

```
//Chapter-3,Example 3_4,Page 3-20
clc()

//given data:
```

```
u1=3.6          //Refractive Index of the Substance at 850 nm
u2=3.4          //Refractive Index of the Substance at 1300 nm
Vv=3*10^8       //Velocity of light in free space

//Calculations:
// i)Finding wavelength at 850 nm
Vs1=Vv/u1                //Velocity of light in substance at 850 nm
printf('Velocity of light in substance at 850 nm =%.2f m/sec \n \n',Vs1)

lam1=850*10^-9/u1       //Wavelength of light in substance at 850nm
printf(' Wavelength of light in substance at 850nm = %.10f m \n \n',lam1)


// ii)Finding wavelength at 1300 nm
Vs2=Vv/u2                //Velocity of light in substance at 1300 nm
printf(' Velocity of light in substance at 1300 nm = %.2f m/sec \n \n',Vs2)

lam2=1300*10^-9/u2      //Wavelength of light in substance at 1300nm
printf(' Wavelength of light in substance at 1300nm =%.10f m \n',lam2)
```

Scilab code Exa 3.5 Find NA acceptance angle and critical angle

```
//Chapter-3,Example 3_5,Page 3-20
clc()

```

```
//Given Data:
u1=1.5                      //R.I. of Core
u2=1.45                     //R.I.of Cladding
del=(u1-u2)/u1              //Fractional Refractive
    index

//Calculations:
NA=u1*sqrt(2*del)                 //Formula to find NA
theta0=asin(NA)*180/%pi           //Acceptance angle
thetac=asin(u2/u1)*180/%pi        //Critical angle

printf('Numerical Aperture of Fibre is =%.3f \n \n',
    NA)
printf(' Acceptance angle of Fibre is =%.2f degrees
    \n \n',theta0)
printf(' Critical angle of Fibre is =%.1f degrees \n
    ',thetac)
```

Scilab code Exa 3.6 `Calculate RI of core and cladding`

```
//Chapter-3,Example 3_6,Page 3-20
clc()

//Given Data:
NA=0.22                 // Numerical Aperture of Fibre
delta=0.012             //Fractional index

//Calculations:
//Delta=(u1-u2)/u1
u1=NA/sqrt(2*delta)     //Formula
u2=u1-(u1*delta)        //Formula

printf('Refractive Index of core of fibre is =%.2f \
    n \n',u1)
printf(' Refractive Index of cladding of fibre is =%
```

```
.2f \n',u2)
```

Scilab code Exa 3.7 Calculate core radius NA and spot size

```
//Chapter-3,Example 3_7,Page 3-21
clc()

//Given Data:
u1=1.466                    //R.I. of Core
u2=1.46                     //R.I.of Cladding
V=2.4                       //Cut off parameter
lam=0.8*10^-6               //wavelength in meter

//Calculations:
NA=sqrt(u1^2-u2^2)          //Formula to find Numerical Aperture
printf('Numerical Aperture of Fibre is =%.2f \n',NA)
//(printing mistake in book)printed answer is 1.13 but correct answer is 0.13
printf('(printing mistake in book) \n \n')

// V = 2*%pi*a*NA / lam
a=V*lam/(2*%pi*NA)    //core radius
printf(' Core radius of Fibre is (a) =%.8f m \n \n',a)

//w/a= 1.1
w=1.1*a                     //Spot size
printf(' Spot size of Fibre is =%.8f m \n \n',w)

theta=2*lam*180/%pi/(%pi*w)         //Divergence angle
printf(' Divergence angle of Fibre is =%.2f degrees \n \n',theta)

w10=lam*10/(%pi*w)          //Spot size at 10 m
```

```
printf(' Spot size at 10 m of Fibre is =%.2f m \n \n
    ',w10)
```

Scilab code Exa 3.8 `Calculate cut off parameter and number of modes`

```
//Chapter-3,Example 3_8,Page 3-21
clc()

//Given Data:
w=98                          //Spot size in meter
d=50*10^-6                    //Core diameter in meter
a=d/2                         //core radius
u1=1.47                       //R.I. of Core
u2=1.45                       //R.I.of Cladding
lam=0.85*10^-6                //Wavlength in meter
NA=sqrt(u1^2-u2^2)            //Formula to find NA

//Calculations:
V=2*%pi*a*NA/lam              //cut off parameter
N=(V^2)/2                     //Number of modes

printf('Cut off parameter of Fibre is =%.4f \n \n',V
    )
printf(' Number of modes of Fibre is =%.0f \n',N)
```

Scilab code Exa 3.9 `Calculate maximum radius`

```
//Chapter-3,Example 3_9,Page 3-21
clc()

//Given Data:
u1=1.47                       //R.I. of Core
u2=1.46                       //R.I.of Cladding
```

```
lam=1.3*10^-6              //wavelength in meter

//Calculations:
NA=sqrt(u1^2-u2^2)         //Formula to find Numerical Aperture

//The condition for single mode is V<2.405
//2*%pi*a*NA/lam < 2.405

a=2.405*lam/(2*%pi*NA)     //Maximum radius of fibre

printf('Maximum radius of Fibre is =%.8f meter \n',a)
```

Scilab code Exa 3.10 Calculate refractive index

```
//Chapter-3,Example 3_10,Page 3-22
clc()

//Given Data:
u1=1.465                   //R.I. of Core
u2=1.46                    //R.I.of Cladding
lam=1.25*10^-6             //operating wavelength

//Calculations:
del=(u1-u2)/u1             //Fractional Refractive index
printf('Fractional Refractive index of Fibre is =%.6f \n \n',del)

//For single mode propagation codition is
// a/lam< 1.4/(%pi*sqrt(u1(u1-u2)))

a=lam*1.4/(%pi*u1*sqrt(del))       //core radius

```

```
u=u1-(sqrt(2*del)/(2*%pi*(a/lam)))      //effective refractive index
printf(' Effective Refractive index for lowest mode propagation is =%.3f \n',u)
```

Scilab code Exa 3.11 Calculate cut off parameter and number of modes

```
//Chapter-3,Example 3_11,Page 3-22
clc()

//Given Data:
u1=1.54                     //R.I. of Core
u2=1.5                      //R.I.of Cladding
lam=1.3*10^-6               //wavelength in meter
a=25*10^-6                  //core radius in meter

//Calculations:
NA=sqrt(u1^2-u2^2)          //Formula to find Numerical Aperture

V=2*%pi*a*NA/lam            //cut off parameter
printf('Cut off parameter of Fibre is =%.2f \n \n',V)

N=(V^2)/2                   //Number of modes
printf(' Number of modes of Fibre is =%.0f \n',N)
```

Scilab code Exa 3.11.1 Find Normalised frequency and number of modes

```
//Chapter-3,Example 3_11_1,Page 3-25
clc()

//Given Data:
```

```
u1=1.52                     //R.I. of Core
u2=1.5189                   //R.I.of Cladding
lam=1.3*10^-6               //wavelength in meter
d=29*10^-6                  //core diameter in meter
a=d/2

//Calculations:
NA=sqrt(u1^2-u2^2)          //Formula to find Numerical
    Aperture
V=2*%pi*a*NA/lam            //Normalised frequency
Nm=(V^2)/2                  //Number of modes

printf('Normalised frequency of Fibre is (V)=%.3f \n
    \n',V)
printf(' The Maximum Number of modes the Fibre will
   support is (Nm) =%.0f \n',Nm)
```

Scilab code Exa 3.12 Compute delta and acceptance angle

```
//Chapter-3,Example 3_12,Page 3-22
clc()

//Given Data:
u1=1.5                     //R.I. of Core
d=10*10^-6                 //diameter of core
a=d/2                      //core radius
lam=1.3*10^-6              //wavelength
V=2.405                    //cut off parameter for
   single mode

//Calculations:

//We know, V=2*%pi*a*NA/lam
NA=V*lam/(2*%pi*a)          //Numerical Aperture

```

```
theta=asin(NA)*180/%pi    //Acceptance angle
printf('Acceptance angle of Fibre is =%.2f degrees \n \n',theta)

//Also, NA=u1*sqrt(2*del)
del=(NA/u1)^2/2             //Fractional index
printf(' Maximum Fractional Refractive index of Fibre is =%.4f \n \n',del)

//del=(u1-u2)/u1
u2=u1*(1-del)               //R.I.of cladding
printf(' Refractive index of cladding of Fibre is =%.3f \n',u2)
```

Scilab code Exa 3.13 `Calculate cladding index various angles and NA of fibre`

```
//Chapter-3,Example 3_13,Page 3-23
clc()

//Given Data:
n1=1.5                  //R.I. of core
delta=0.0005            //Fractional index difference

//Calculations:
//(a):
//Delta=(u1-u2)/u1
n2=n1-(n1*delta)       //R.I. of cladding
printf('(a)Refractive Index of cladding of fibre is =%.2f \n \n',n2)

//(b):
phi=asin(n2/n1)*180/%pi          //Critical internal reflection angle
printf(' (b)Critical internal reflection angle of Fibre is =%.1f degrees \n \n',phi)
```

```

//(c):
theta0=asin(sqrt(n1^2-n2^2))*180/%pi    //External critical Acceptance angle
printf(' (c)External critical Acceptance angle of Fibre is =%.2f degrees \n \n',theta0)

//(d):
NA=n1*sqrt(2*delta)            //Formula to find Numerical Aperture
printf(' (d)Numerical Aperture of Fibre is =%.4f \n',NA)
```

Scilab code Exa 3.14 Calculate acceptance angle

```
//Chapter-3,Example 3_14,Page 3-24
clc()

//Given Data:
NA1=0.20                  //Numerical Aperture of Fibre
n2=1.59                   //R.I. of cladding

//Calculations:
// NA=sqrt(n1^2-n2^2)
//In air , n0=1
n1=sqrt(NA1^2+n2^2)       //R.I.of core

//Now, in water
n0=1.33
NA2=sqrt(n1^2-n2^2)/n0        //Numerical Aperture in water
theta0=asin(NA2)*180/%pi      //Acceptance angle of fibre in water
printf('Acceptance angle of Fibre in water is =%.1f degrees \n',theta0)
```

Scilab code Exa 3.15 Calculate NA and acceptance angle

```
//Chapter-3,Example 3_15,Page 3-24
clc()

//Given Data:
n1=1.45                  //R.I.of core
n2=1.40                  //R.I. of cladding

//Calculations:
NA=sqrt(n1^2-n2^2)    //Numerical Aperture
printf('Numerical Aperture of Fibre is =%.4f \n \n',
    NA)

theta0=asin(NA)*180/%pi     //Acceptance angle of
    fibre
printf(' Acceptance angle of Fibre is =%.2f degrees
    \n',theta0)
```

Scilab code Exa 3.16 Calculate acceptance angle and RI of cladding

```
//Chapter-3,Example 3_16,Page 3-24
clc()

//Given Data:
NA=0.16                  //Numerical Aperture of Fibre
n1=1.45                  //R.I. of core
d=90*10^-6               //Core diameter

//Calculations:
//NA=sqrt(n1^2-n2^2)
```

```
n2=sqrt(n1^2-NA^2)     //R.I.of cladding
printf('(a)Refractive Index of cladding of fibre is
   =%.3f \n \n',n2)

theta0=asin(NA)*180/%pi     //Acceptance angle of
   fibre
printf(' (b)Acceptance angle of Fibre is =%.2f
   degrees \n',theta0)
```

Scilab code Exa 3.17 Find NA Cladding index acceptance angle and number of modes

```
//Chapter-3,Example 3_17,Page 3-25
clc()

//Given Data:
n1=1.48                //R.I. of core
delta=0.055            //Realtive R.I.
lam=1*10^-6            //Wavelength of light
a=50*10^-6             //core radius

//Calculations:
//Delta=(u1-u2)/u1
n2=n1-(n1*delta)       //R.I. of cladding
NA=n1*sqrt(2*delta)    //Formula to find Numerical
   Aperture
printf('Numerical Aperture of Fibre is =%.4f \n \n',
   NA)


theta0=asin(NA)*180/%pi      //Acceptance angle of
   fibre
printf(' Acceptance angle of Fibre is =%.2f degrees
   \n \n',theta0)

V=2*%pi*a*NA/lam             //V number
```

```
N=(V^2)/2                    //Number of guided modes

//In book,instead of NA , value of delta is taken
    into calculation.
//Thus there is calculation mistake in values of V
    and N.

printf(' V number of Fibre is =%.3f \n \n',V)
printf(' Number of guided mode of Fibre is =%.3f \n'
    ,N)
printf('(Calculation mistake in book)')
```

Chapter 4

Laser

Scilab code Exa 4.1 Find ratio of population of two energy states

```
//Chapter-4,Example 4_1,Page 4-27
clc()

//Given Data:
lam=694.3*10^-9          //Wavelength in meter
T=300                    //Temperature in Kelvin

h=6.63*10^-34            //Planck's Constant
c=3*10^8                 //Velocity of light
K=1.38*10^-21            //Boltzmann Constant

//Calculations:
delE= h*c/lam            //Energy difference between
   two energy states N and N0

//N=N0*e^-delE/(K*T)
R=%e^(-delE/(K*T))       //R=Ratio of N and N0 i.e.(R
   =N/N0)

//(Printing mistake in textbook)
//instead of e^-.692, it has taken e^-69.2
```

```

printf('The ratio of population of two energy states is = %.8f \n',R)
printf(' (calculation mistake in book)')
```

Scilab code Exa 4.2 Find number of photons emitted per second

```
//Chapter-4,Example 4_2,Page 4-28
clc()

//Given Data:
lam=6328*10^-10           //Wavelength in meter
P=4.5*10^-3               //Power in watts
h=6.63*10^-34             //Planck's Constant
c=3*10^8                  //Velocity of light

//Calculations:
delE= h*c/lam             //Energy difference
//N*delE=P
N=P/delE                  //number of photons emitted per second

printf('Number of photons emitted per second is =%.1f \n',N)
```

Scilab code Exa 4.3 Calculate number of photons in each pulse

```
//Chapter-4,Example 4_3,Page 4-29
clc()

//Given Data:
lam=780*10^-9             //Wavelength of photon in meter
```

```
P=20*10^-3                    //Power of each pulse in watts
t=10*10^-9                    //Duration of each pulse
h=6.63*10^-34                 //Planck's Constant
c=3*10^8                      //Velocity of light

//Calculations:
delE= h*c/lam                 //Energy of each photon
E=P*t                         //Energy of each pulse

N=E/delE                      //Number of photons in each pulse
printf('Number of photons in each pulse is =%.1f \n',N)
```

Chapter 5

Foundations of Quantum Mechanics

Scilab code Exa 5.1 `Calculate de Broglie wavelength`

```
//Chapter-5,Example 5_1,Page 5-23
clc()

//Given Values:
m=6.68*10^-27          //mass of alpha particle
V=30*10^3              //potential difference
e=1.6*10^-19           //charge of an electron
q=2*e                  //Charge of alpha particle
h=6.63*10^-34          //Planck's constant

//Calculations:
lam=h/sqrt(2*m*q*V)        //de Broglie wavelength
printf('de Broglie wavelength associated with alpha
    particle is =%.16f m \n',lam)
```

Scilab code Exa 5.2 `Calculate de Broglie wavelength`

```
//Chapter-5,Example 5_2,Page 5-23
clc()

//Given Values:
m=1                    //mass of given particle in kg
h=6.63*10^-34          //Planck's constant
v=1*10^3               //velocity of particle

//Calculations:
lam=h/(m*v)            //de Broglie wavelength
printf('de Broglie wavelength associated with particle is =%.40f m \n \n',lam)
printf(' This wavelength is too small for any practical significance.')
```

Scilab code Exa 5.3 `Calculate de Broglie wavelength`

```
//Chapter-5,Example 5_3,Page 5-24
clc()

//Given Values:
m1=40*10^-3            //mass of bullet in kg
m2=9.1*10^-31          //mass of electron in kg
h=6.63*10^-34          //Planck's constant
v=1100                 //velocity of bullet and electron

//Calculations:
lam1=h/(m1*v)           //de Broglie wavelength
printf('de Broglie wavelength associated with bullet is =%.36f m \n \n',lam1)

lam2=h/(m2*v)           //de Broglie wavelength
printf(' de Broglie wavelength associated with electron is =%.10f m \n \n',lam2)
```

```

printf(' Wavelength of bullet is too small.Hence it
    can not be measured with help of diffraction
    effect.')
```

Scilab code Exa 5.4 Find Glancing angle

```
//Chapter-5,Example 5_4,Page 5-24
clc()

//Given Values:
V=100              //potential difference
d=2.15*10^-10      //lattice spacing

//Calculations:
lam=12.26*10^-10/(sqrt(V))            //wavelength
    associated with electron in meter

//using bragg's law for first order  lam=2d sin(
    theta)
theta=asin(lam/(2*d))*180/%pi         //glancing angle
     in degrees
printf('Glancing angle at which first reflection
    occurs is =%.2f degrees \n',theta)
```

Scilab code Exa 5.5 Find Energy

```
//Chapter-5,Example 5_5,Page 5-25
clc()

//Given Values:
mn=1.674*10^-27       //mass of neutron
h=6.63*10^-34         //Planck's constant
```

```
lam=1*10^-10          //wavelength of neutron

//Calculations:

//we know,  lam=h/sqrt(2*m*E)      //de Broglie wavelength
E1=h^2/(2*mn*lam^2)    //Energy of neutron in joules
E=E1/(1.6*10^-19)      //Energy of neutron in electron-Volts

printf('Energy of neutron is =%.3f eV \n',E)
```

Scilab code Exa 5.6 Calculate KE and Braggs angle

```
//Chapter-5,Example 5_6,Page 5-25
clc()

//Given Values:
mn=1.67*10^-27        //mass of neutron
h=6.6*10^-34          //Planck's constant
lam=3*10^-10          //wavelength of neutron
d=3.036*10^-10        //lattice spacing

//Calculations:

//we know,  lam=h/sqrt(2*m*E)      //de Broglie wavelength
E1=h^2/(2*mn*lam^2)   //Energy of neutron in joules
E=E1/(1.6*10^-19)     //Energy of neutron in electron-Volts
printf('Energy of neutron is =%.5f eV \n \n',E)

//using bragg's law for first order  lam=2d sin(theta)
theta=asin(lam/(2*d))*180/%pi       //glancing angle
```

```
in degrees
printf(' Glancing angle at which first orde reflection occurs is =%.0f degrees \n',theta)
```

Scilab code Exa 5.7 `Calculate kinetic energy`

```
//Chapter-5,Example 5_7,Page 5-26
clc()

//Given Values:
m=9.108*10^-31          //mass of electron
h=6.625*10^-34          //Planck's constant
lam=5*10^-7             //wavelength of electron

//Calculations:

//we know,  lam=h/sqrt(2*m*E)       //de Broglie wavelength
E1=h^2/(2*m*lam^2)      //Energy of electron in joules
E=E1/(1.6*10^-19)       //Energy of electron in electron-Volts
printf('Energy of electron is =%.9f eV \n',E)
```

Scilab code Exa 5.8 `Calculate wavelength energy and momentum`

```
//Chapter-5,Example 5_8,Page 5-27
clc()

//Given Values:
mn=1.676*10^-27         //mass of neutron
me=9.1*10^-31           //mass of electron
h=6.625*10^-34          //Planck's constant
```

```

//Calculations:
//Part 1:
En1=0.025                  //Energy in eV of neutron
En=En1*(1.6*10^-19)        //Energy in joules

lam1=h/sqrt(2*mn*En)       //wavelength of a beam of neutron
printf('wavelength of a beam of neutron is =%.13f m \n \n',lam1)

//Part 2:
lam2=2*10^-10              //wavelength of electron and photon

//we know, lam=h/sqrt(2*m*E)       //de Broglie wavelength
Ee1=h^2/(2*me*lam2^2)      //Energy of electron in joules
Ee=Ee1/(1.6*10^-19)        //Energy of electron in electron-Volts
printf(' Energy of electron is =%.3f eV \n \n',Ee)

p1=h/lam2                  //momentum of electron
printf(' Momentum of electron is =%.27f kg.m/s \n \n',p1)

C=3*10^8                   //Velocity of light
Ep=h*C/lam2                //Energy of photon in joules
printf(' Energy of photon is =%.19f Joules \n \n',Ep)

p2=h/lam2                  //momentum of photon
printf(' Momentum of photon is =%.27f kg.m/s \n \n',p2)
```

Scilab code Exa 5.9 Find shortest wavelength

```
//Chapter-5,Example 5_9,Page 5-28
clc()

//Given data:
//We have alpha particle,neutron,proton and electron
   .

//To find: shortest wavelength

printf('We know, lam=h/sqrt(2*m*E)      //de Broglie
   wavelength  \n \n')

//Wavelength is inversely proportional to mass of
   particle for constant energy
printf(' i.e., Wavelength is inversely proportional
   to mass of particle for constant energy. \n \n')

printf(' We have alpha particle,neutron,proton and
   electron. \n \n')

//AS,alpha particle has highest mass.Thus it will
   have shortest wavelength.
printf(' Out of above, alpha particle has highest
   mass. \n \n')

printf(' Hence it will have shortest wavelength. \n
   \n')
```

Scilab code Exa 5.10 Calculate energies

```
//Chapter-5,Example 5_10 ,Page 5-28
clc()

//Given Values:
me=9.108*10^-31        //mass of electron
mp=1.66*10^-27         //mass of proton
h=6.625*10^-34         //Planck's constant
lam=1*10^-10           //wavelength of electron and proton

//Calculations:

//we know,   lam=h/sqrt(2*m*E)      //de Broglie wavelength
Ee1=h^2/(2*me*lam^2)        //Energy of electron in joules
Ee=Ee1/(1.6*10^-19)         //Energy of electron in electron-Volts
printf('Energy of electron is =%.2f eV \n \n',Ee)

Ep1=h^2/(2*mp*lam^2)        //Energy of photon in joules
Ep=Ep1/(1.6*10^-19)         //Energy of photon in electron-Volts
printf(' Energy of photon is =%.2f eV \n \n',Ep)
```

Scilab code Exa 5.11 Compare de Broglie wavelengths

```
//Chapter-5,Example 5_11 ,Page 5-29
clc()

//Given Values:
m1=50*10^-9          //mass of particle in kg
m2=9.1*10^-31        //mass of electron in kg
h=6.625*10^-34       //Planck's constant
```

```
v1=1                    //velocity of particle
v2=3*10^6               //velocity of electron

//Calculations:
lam1=h/(m1*v1)*10^10          //de Broglie wavelength
printf('de Broglie wavelength associated with
   particle is =%.20f Angstrom \n \n',lam1)

lam2=h/(m2*v2)*10^10          //de Broglie wavelength
printf(' de Broglie wavelength associated with
   electron is =%.3f Angstrom \n \n',lam2)

printf(' Wavelength of electron is measurable.')
```

Scilab code Exa 5.12 Calculate de Broglie wavelength

```
//Chapter-5,Example 5_12,Page 5-29
clc()

//Given Values:
me=9.1*10^-31            //mass of electron in kg
h=6.63*10^-34           //Planck's constant

//Calculations:

E1=2*10^3               //Energy in eV of electron
E=E1*(1.6*10^-19)       //Energy in joules

lam=h/sqrt(2*me*E)       //wavelength of electron
printf('Wavelength of electron is =%.13f m \n',lam)
```

Scilab code Exa 5.13 Calculate momentum and energies

```
//Chapter-5,Example 5_13,Page 5-30
clc()

//Given Values:
me=9.1*10^-31              //mass of electron
h=6.63*10^-34              //Planck's constant
lam=2*10^-10               //wavelength of electron and
    photon

//Calculations:
p1=h/lam                   //momentum of electron
printf('Momentum of electron is =%.27f kg.m/s \n \n'
   ,p1)

Ee=p1^2/(2*me)             //Energy of electron in
   joules
printf(' Energy of electron is =%.21f Joules \n \n',
   Ee)

p2=h/lam                   //momentum of photon
printf(' Momentum of photon is =%.27f kg.m/s \n \n',
   p2)

c=3*10^8                   //Velocity of light
Ep=h*c/lam                 //Energy of photon in joules
printf(' Energy of photon is =%.19f Joules \n \n',Ep
   )
```

Scilab code Exa 5.14 Compare energies

```
//Chapter-5,Example 5_14,Page 5-31
clc()

//Given Values:
m=1.676*10^-27             //mass of neutron
```

```
h=6.625*10^-34              //Planck's constant
lam=1*10^-10                //wavelength of neutron

//Calculations:
C=3*10^8                    //Velocity of light
Ep1=h*C/lam                 //Energy of photon in joules
E1=Ep1/(1.6*10^-19)         //Energy of photon in electron-Volts
printf('Energy of photon is =%.2f eV \n \n',E1)

//we know,  lam=h/sqrt(2*m*E)      //de Broglie wavelength
En1=h^2/(2*m*lam^2)         //Energy of neutron in joules
E2=En1/(1.6*10^-19)         //Energy of neutron in electron-Volts
printf(' Energy of neutron is =%.3f eV \n \n',E2)

R=E1/E2                     //Ratio of energies of proton to neutron
printf(' Ratio of energies of proton to neutron is = %.0f \n \n',R)
```

Scilab code Exa 5.14.1 `Find uncertainty in position`

```
//Chapter-5,Example 5_14_1,Page 5-36
clc()

//Given Values:
v=900                       //velocity of electron in m/s
delv=v*0.001/100            //uncertainity in velocity
h=6.63*10^-34               //Planck's constant
m=9.1*10^-31                //mass of an electron

//Calculations:
```

```
delp=m*delv                 //uncertainity in the measured values of momentum

//using heisenberg's uncertainity formula
delx=h/(2*%pi*delp)     //uncertainity in its position
printf('Uncertainity with which position of electron can be located is >=%.5f m \n',delx)
```

Scilab code Exa 5.14.2 Calculate de Broglie wavelength

```
//Chapter-5,Example 5_14_2,Page 5-37
clc()

//Given Values:
m=1.6*10^-27          //mass of proton in kg
h=6.63*10^-34         //Planck's constant
v=3/20*10^8           //velocity of particle

//Calculations:
lam=h/(m*v)          //de Broglie wavelength
printf('de Broglie wavelength associated with proton is =%.18f m \n \n',lam)
```

Scilab code Exa 5.14.3 Calculate wavelength

```
//Chapter-5,Example 5_14_3,Page 5-37
clc()

//Given Values:
m=1.676*10^-27          //mass of neutron
h=6.634*10^-34          //Planck's constant

```

```
//Calculations:
E1=0.025                //Energy in eV of neutron
E=E1*(1.6*10^-19)       //Energy in joules
//As E=m*v^2/2
v=sqrt(2*E/m)           //Velocity of neutron beam

lam=h/(m*v)             //wavelength of a beam of
   neutron
printf('wavelength of a beam of neutron is =%.13f m
   \n',lam)
```

Scilab code Exa 5.14.4 Find percent of uncertainty in momentum

```
//Chapter-5,Example 5_14_4,Page 5-37
clc()

//Given Values:
delx=10*10^-9             //uncertainity in position of
    electron
h=6.63*10^-34             //Planck's constant
m=9.1*10^-31              //mass of an electron
E=10^3*1.6*10^-19         //Energy of electron in
   joules

//Calculations:
p=sqrt(2*m*E)             //momentum of electron
//using heisenberg's uncertainity formula
delp=h/(2*%pi*delx)       //uncertainity in the
   momentum

P=delp/p*100              //percentage of uncertainity
   in momentum
printf('Percentage of uncertainity in momentum of
   electron is =%.5f percent \n',P)
```

Scilab code Exa 5.15 Calculate KE phase and group velocity

```
//Chapter-5,Example 5_15,Page 5-31
clc()

//Given Values:
m=1.676*10^-27              //mass of neutron
h=6.63*10^-34               //Planck's constant
lam=2*10^-12                //wavelength of neutron
c=3*10^8                    //Velocity of light

//Calculations:
p=h/lam                     //momentum of neutron
KE=p^2/(2*m)                //Kinetic Energy of neutron
    in joules
printf('Kinetic Energy of electron is =%.21f Joules
    \n \n',KE)

//velocity of particle is same as group velocity.
    Thus,
vg=p/m                      //group velocity
printf(' group velocity of neutron is =%.0f m/s \n \
    n',vg)

//using, vg*vp=c^2
vp=c^2/vg                   //phase velocity
printf(' phase velocity of neutron is =%.0f m/s \n \
    n',vp)
```

Scilab code Exa 5.16 Calculate de Broglie wavelength and group and phase velocity

```
//Chapter-5,Example 5_16,Page 5-32
```

```
clc()

//Given Values:
m=1.157*10^-30           //mass of particle in kg
h=6.63*10^-34            //Planck's constant
c=3*10^8                 //Velocity of light

//Calculations:
E1=80                    //Energy in eV of particle
E=E1*(1.6*10^-19)        //Energy in joules

lam=h/sqrt(2*m*E)        //wavelength of particle
printf('Wavelength of particle is =%.13f m \n \n',
   lam)

//Now,
vg=h/(lam*m)             //group velocity
printf(' Group velocity of particle is =%.0f m/s \n
   \n',vg)

//using, vg*vp=c^2
vp=c^2/vg                //phase velocity
printf(' Phase velocity of particle is =%.0f m/s \n
   \n',vp)
```

Scilab code Exa 5.17 Find accuracy in position

```
//Chapter-5,Example 5_17,Page 5-33
clc()

//Given Values:
v=400                  //velocity of electron in m/s
delv=0.01/100          //uncertainity in velocity
h=6.63*10^-34          //Planck's constant
m=9.11*10^-31          //mass of an electron
```

```
//Calculations:
p=m*v                    //momentum of an electron
delp=p*delv              //uncertainity in the measured
   values of momentum

//using heisenberg's uncertainity formula
delx=h/(2*%pi*delp)     //accuracy in its position
printf('Accuracy in its position is >=%.6f m \n \n',
   delx)
```

Scilab code Exa 5.18 `Calculate minimum uncertainty in velocity`

```
//Chapter-5,Example 5_18,Page 5-33
clc()

//Given Values:
delx=10^-8                 //maximum uncertainity in
   position of electron
h=6.63*10^-34              //Planck's constant
m=9.1*10^-31               //mass of an electron

//Calculations:
//using heisenberg's uncertainity formula
delp=h/(2*%pi*delx)     //minimum uncertainity in the
    measured values of momentum

delv=delp/m                //minimum uncertainity in the
    velocity of an electron
printf('Minimum uncertainity in the velocity of an
   electron is =%.0f m/s \n \n',delv)
```

Scilab code Exa 5.19 `Find minimum space required`

```
//Chapter-5,Example 5_19,Page 5-34
clc()

//Given Values:
delv=2*10^4                //uncertainity in velocity
h=6.63*10^-34              //Planck's constant
m=9.1*10^-31               //mass of an electron

//Calculations:
delp=m*delv                //uncertainity in the measured values of momentum

//using heisenberg's uncertainity formula
delx=h/(2*%pi*delp)        //accuracy in its position
printf('Minimum space required by electron to be confined in an atom is >=%.12f m \n \n',delx)
```

Scilab code Exa 5.20 `Find uncertainty in energy`

```
//Chapter-5,Example 5_20,Page 5-34
clc()

//Given Values:
delt=1.4*10^-10            //uncertainity in time spent by nucleus in excited state
h=6.63*10^-34              //Planck's constant

//Calculations:

//using, delE*delt>= h/(2*%pi)
delE1= h/(2*%pi*delt)         //uncertaininty in its energy in excited state in joules
delE=delE1/(1.6*10^-19)       //uncertaininty in its energy in excited state in eV
printf('Uncertaininty in its energy in excited state
```

```
is >=%.8f eV \n',delE)
```

Scilab code Exa 5.21 Find energies

```
//Chapter-5,Example 5_21,Page 5-35
clc()

//Given Values:
a=2*10^-10                 //width of potential well in
   m
h=6.63*10^-34              //Planck's constant
m=9.1*10^-31               //mass of an electron

//Calculations:
//we know equation for energy of an electron
n0=1
E01=n0^2*h^2/(8*m*a^2)     //Energy in ground state
E0=E01/(1.6*10^-19)        //Energy in eV
printf('Energy of an electron in ground state is=%.3
   f eV \n \n',E0)

n1=2
E11=n1^2*h^2/(8*m*a^2)     //Energy in first excited
   state
E1=E11/(1.6*10^-19)        //Energy in eV
printf(' Energy of an electron in first excited
   state is=%.2f eV \n \n',E1)


n2=3
E21=n2^2*h^2/(8*m*a^2)     //Energy in second excited
   state
E2=E21/(1.6*10^-19)        //Energy in eV
printf(' Energy of an electron in second excited
   state is=%.2f eV \n',E2)
```

Scilab code Exa 5.22 calculate probability of finding particle

```

//Chapter-5,Example 5_22,Page 5-36
clc()

//Given Values:
a=25*10^-10                 //width of well
delx=5*10^-10               //uncertainity in position of particle
n=1                         //ground state

//calculation:
x1=a/2
psi1=sqrt(2/a)*sin(n*%pi/a*x1)
P1=(psi1^2)*delx                //Probability of finding particle at distance of x1
printf('Probability of finding particle at a distance of x1 is =%.2f \n \n',P1)

x2=a/3
psi2=sqrt(2/a)*sin(n*%pi/a*x2)
P2=(psi2^2)*delx                //Probability of finding particle at distance of x2
printf(' Probability of finding particle at a distance of x2 is =%.2f \n',P2)
printf(' (There is print mistake in book). \n \n')

x3=a
psi3=sqrt(2/a)*sin(n*%pi/a*x3)
P3=(psi3^2)*delx                //Probability of finding particle at distance of x3
printf(' Probability of finding particle at a distance of x3 is =%.2f \n',P3)
```

Chapter 6

Magnetic Materials and Circuits

Scilab code Exa 6.1 `Find flux density and Relative permeability`

```
//Chapter-6,Example 6_1,Page 6-26
clc()

//Given Values:
H=198                    //Magnetizing Force in Ampere per meter
M=2300                   //Magnetization in Ampere per meter
u0=4*%pi*10^-7           //Permeability in vacuum

//Calculations:
//H=(B/u0)-M
B=u0*(H+M)               //Flux Density
ur=B/(u0*H)              //Relative Permeability

printf('Corresponding Flux Density is =%.5f Wb/m^2 \n \n',B)
printf(' Relative Permeability is =%.2f \n',ur)
```

Scilab code Exa 6.2 Find relative permeability

```
//Chapter-6,Example 6_2,Page 6-26
clc()

//Given Values:
x=3.7*10^-3              //Susceptibility at T=300 K
T=300                    //Temperature in kelvin
T1=250                   //Temperature in kelvin
T2=600                   //Temperature in kelvin

//Calculations:
C=x*T                   //Curie's law
ur1=C/T1                //Relative permeability at 250
    K
ur2=C/T2                //Relative permeability at 600
    K

printf('Relative Permeability at 250 K is =%.6f \n \
   n',ur1)
printf(' Relative Permeability at 600 K is =%.6f \n'
   ,ur2)
```

Scilab code Exa 6.3 Calculate temperature

```
//Chapter-6,Example 6_3,Page 6-27
clc()

//Given Values:
u=0.8*10^-23            //Magnetic dipole moment of an
    atom in paramagnetic gas in J/T
B=0.8                   //Magnetic field in tesla
```

```
K=1.38*10^-23            //Boltzmann constant

//To find Temperature at which Average thermal
   energy is equal to Magnetic energy
//i.e. uB=3KT/2
T=2*u*B/(3*K)            //Required temperature

printf('Required temperature is =%.3f Kelvin \n',T)
```

Scilab code Exa 6.4 Calculate Magnetization

```
//Chapter-6,Example 6_4,Page 6-27
clc()

//Given Values:
T=27+273              //Temperature in kelvin
B=0.5                 //Magnetic field in tesla
C=2*10^-3             //Curie's Constant
u0=4*%pi*10^-7        //Permeability in vacuum

// C=u0*M*T/B (Curie's law)
M=C*B/(u0*T)          //Magnetization of material at 300
    K

printf('Magnetization of material at 300 K is =%.2f
   A/m \n',M)
```

Scilab code Exa 6.5 Calculate horizontal component of B

```
//Chapter-6,Example 6_5,Page 6-27
clc()

//Given Values:
```

```
B=10.9*10^-5                //Horizontal component of B
    in wb/m^2
u0=4*%pi*10^-7              //Permeability in free space

H=B/u0                      //Horizontal component of
    magnetic field
printf('Horizontal component of magnetic field is =%
    .1f Ampere/meter \n',H)
printf(' (Print mistake in unit in book)')
```

Scilab code Exa 6.6 `Calculate current`

```
//Chapter-6,Example 6_6,Page 6-28
clc()

//Given Values:
u0=4*%pi*10^-7          //Permeability in vacuum
ur=900                  //Relative permeability of medium
l=2                     //length in meter
A=60*10^-4              //Crosss sectional area of ring
    in m^2
phi=5.9*10^-3           //flux in weber
n=700                   //Number of turns

//Calculations:
//We know, phi=B*A
B=phi/A                 //Flux density
//But, B=u*H
H=B/(u0*ur)             //Magnetic field strength

I=H*l/n                 //Required current
printf('Current required to produce given flux is =%
    .2f Ampere \n',I)
```

Scilab code Exa 6.7 Calculate current

```
//Chapter-6,Example 6_7,Page 6-28
clc()

//Given Values:

u0=4*%pi*10^-7        //Permeability in vacuum
ur=900                //Relative permeability of medium
r=25*10^-2            //radius of ring
A=25*10^-4            //Crosss sectional area of ring
    in m^2
Ag=1*10^-3            //Air gap
phi=2.7*10^-3         //flux in weber
N=400                 //Number of turns

//Calculations:
//We know, phi=B*A
B=phi/A               //Flux density
//But, B=u*H
H=B/(u0*ur)           //Magnetic field strength
L=H*2*%pi*r+(B*Ag/u0)    //Total amp turns required (
    iron+air)
I=L/N              //Required current

printf('Current required to produce given flux is =%
    .2f Ampere \n',I)
```

Scilab code Exa 6.8 Calculate permeablity and susceptibility

```
//Chapter-6,Example 6_8,Page 6-29
clc()
```

```

//Given Values:

u0=4*%pi*10^-7          //Permeability in vacuum
A=0.2*10^-4             //Crosss sectional area of iron bar in m^2
H=1600                  //magnetising field in A/m
phi=2.4*10^-5           //Magnetic flux in weber


//Calculations:
//We know, phi=B*A
B=phi/A                 //Flux density
u=B/H                   //magnetic permeability
ur=u/u0                 //relative permeability
xm=ur-1                 //susceptibility of the iron bar

printf('magnetic permeability of iron bar is =%.6f N/(A^2) \n \n',u)
printf(' susceptibility of the iron bar is =%.2f \n',xm)
```

Scilab code Exa 6.9 `Calculate permeability and susceptibility`

```
//Chapter-6,Example 6_9,Page 6-29
clc()

//Given Values:
u0=4*%pi*10^-7            //Permeability in vacuum
xm=948*10^-11             //susceptibility of the iron bar

//Calculations:
ur=1+xm                 //relative permeability
u=u0*ur                 //permeability of medium
```

```
printf('Relative Permeability of medium is =%.8f \n \n',ur)
printf(' Permeability of medium is =%.9f H/m \n',u)
```

Scilab code Exa 6.10 `Calculate relative permeability`

```
//Chapter-6,Example 6_10,Page 6-30
clc()

//Given Values:
B=2.5                 //Magnetic field in tesla
u0=4*%pi*10^-7        //Permeability in free space
i0=0.7                //current in the core
ri=11*10^-2           //inner radii of core
ro=12*10^-2           //outer radii of core

//Calculations:
r=(ri+ro)/2            //Average radii of core
n=3000/(2*%pi*r)       //Number of turns

//We know, B=u0*ur*n*i0 .Thus,
ur=B/(u0*n*i0)

printf('Relative Permeability of medium is =%.2f \n',ur)
```

Scilab code Exa 6.11 `Calculate relative permeability`

```
//Chapter-6,Example 6_11,Page 6-31
clc()

//Given Values:
```

```
B=1.0                  //Flux density in tesla
u0=4*%pi*10^-7         //Permeability in free space
i=2.0                  //current in the core
n=10*100               //n=N/l i.e. turns per meter

//Calculations:
H=n*i                   //Magnetising force produced in wire
printf('Magnetising force produced in wire is =%.2f Amp-turn/meter \n \n',H)

//We know that, B=u0(H+I).Thus,
I=B/u0-H               //Magnetisation of material
printf(' Magnetisation of material is =%.2f Amp-turn/meter \n \n',I)

//u=B/H, i.e. ur*u0=B/H.
ur=B/(u0*H)            //Relative permeability of core
printf(' Relative Permeability of core is =%.1f \n',ur)
```

Scilab code Exa 6.12 Calculate energy loss

```
//Chapter-6,Example 6_12,Page 6-31
clc()

//Given Values:
M=40                 //Mass of an iron core
D=7.5*10^3           //Density of iron
f=100                //Frequency
A=3800*10^-1         //Loss due to Area of hysterisis loop in J/m^3

//Calculations:
V=M/D               //Volume of iron core
```

```
L1=A*V              //Loss of energy in core per cycle
printf('Loss of energy in core per cycles is =%.2f Joules \n \n',L1)

N=f*60              //Number of cycles per minute
L=L1*N              //Loss of energy per minute

printf(' Loss of energy per minute is =%.1f Joules \n',L)
```

Scilab code Exa 6.13 `Calculate flux density and permeability`

```
//Chapter-6,Example 6_13,Page 6-32
clc()

//Given Values:
u0=4*%pi*10^-7        //Permeability in vacuum
l=30*10^-2            //length in meter
A=1*10^-4             //Crosss sectional area of ring in m^2
phi=2*10^-6           //flux in weber
N=300                 //Number of turns
I=0.032               //Current in winding

//Calculations:
//(i):
B=phi/A               //Flux density
printf('i)Flux Density in the ring is =%.2f Wb/m^2 \n \n',B)

//(ii):
H=N*I/l               //Magnetic intensity
printf(' ii)Magnetic intensity is =%.0f Amp-turn/meter \n \n',H)

```

```
//(iii):
u=B/H                   //Permeability of ring
printf(' iii)Permeability of ring is =%.6f Wb/A-m \n
    \n',u)
ur=u/u0                 //Relative permeability of ring
printf(' Relative Permeability of ring is =%.1f \n \
   n',ur)

//(iv):
xm=ur-1                 //susceptibility of the ring
printf(' iv)Magnetic susceptibility of the ring is =
   %.2f \n \n',xm)
```

Scilab code Exa 6.14 Calculate loss of energy

```
//Chapter-6,Example 6_14,Page 6-32
clc()

//Given Values:
M=12*10^3             //Mass of an iron core in grams
D=7.5                 //Density of iron in gm/cc
f=50                  //Frequency
A=3000                //Loss due to Area of hysterisis
   loop in ergs/cm^3

//Calculations:
V=M/D                //Volume of iron core
L1=A*V               //Loss of energy in core per cycle

L=L1*f*3600          //Loss of energy per hour

printf('Loss of energy per hour is =%.0f Erg \n',L)
```

Scilab code Exa 6.15 Calculate hysteresis power loss

```
//Chapter-6,Example 6_15,Page 6-33
clc()

//Given Values:
A=0.5*10^3                    //Area of B-H loop in Joules
    per m^3
V=10^-3                       //Volume of specimen in m^3
n=50                          //Frequency of a.c.

//Calculations:
H=n*V*A                       //Hysteresis power loss

printf('Hysteresis power loss is =%.0f Watt \n',H)
```

Scilab code Exa 6.16 Find magnetic moment

```
//Chapter-6,Example 6_16,Page 6-3
clc()

//Given Values:
u0=4*%pi*10^-7          //Permeability in vacuum
ur=1000                 //Relative permeability of medium
V=10^-4                 //Volume of iron rod in m^3
n=500                   //Number of turns per meter
i=0.5                   //Current in windings of solenoid
    in Amperes

//Calculations:
//We know I=(ur-1)H
//and H=ni , hence
I=(ur-1)*n*i            //Intensity of magnetisation
M=I*V                   //Magnetic moment

```

```
printf('Magnetic moment of the rod is =%.0f A-m^2 \n',M)
```

Scilab code Exa 6.17 Find flux density and magnetic intensity

```
//Chapter-6,Example 6_17,Page 6-34
clc()

//Given Values:
u0=4*%pi*10^-7       //Permeability in vacuum
ur=600               //Relative permeability of iron
d=12*10^-2           //mean diameter of ring in m
N=500                //Number of turns
i=0.3                //Current in windings of solenoid in Amperes

//Calculations:
r=d/2                      //Radius of ring

B=u0*ur*N*i/(2*%pi*r)      //Flux densityin the core
printf('Flux densityin the core is =%.1f Wb/m^2 \n \n',B)

H=B/(u0*ur)               //Magnetic intensity
printf(' Magnetic intensity is =%.1f Amp-turns/m \n \n',H)

//We know that, B=u0(H+I)
I1=(B-u0*H)/u0             //magnetisation
I2=u0*I1                   //Electronic current loop

I=I2/B*100                 //Percentage flux density due to electroniuc loop currents
printf(' Percentage flux density due to electroniuc loop currents is =%.2f percent \n \n',I)
```

Scilab code Exa 6.18 `Calculate current`

```
//Chapter-6,Example 6_18,Page 6-35
clc()

//Given Values:

u0=4*%pi*10^-7          //Permeability in vacuum
ur=900                  //Relative permeability of iron ring
d=40*10^-2              //diameter of ring
l=5*10^-3               //air gap in the ring
A=5.8*10^-4             //Crosss sectional area of ring in m^2
phi=1.5*10^-4           //flux in weber
N=600                   //Number of turns

//Calculations:
r=d/2                   //Radius of ring

//We know, phi=B*A
B=phi/A                 //Flux density

//But, B=u*H
H=B/(u0*ur)             //Magnetic field strength

m1=H*ur*l               //amp-turns in air gap
m2=H*2*%pi*r            //amp-turns by ring
m=m1+m2                 //total mmf(amp-turns) required

I=m/N                   //Required current
printf('Current required to produce given flux is =%.2f Amperes \n',I)
```

Scilab code Exa 6.18.1 Find magnetic flux density

```
//Chapter-6,Example 6_18_1,Page 6-38
clc()

//Given Values:
u0=4*%pi*10^-7          //Permeability in vacuum
X=-0.5*10^-5            //Magnetic susceptibility of
   silicon
H=9.9*10^4              //Magnetic field intensity

//Calculations:

//As, X=I/H. thus,
I=X*H                   //intensity of magnetisation
printf('Intensity of magnetisation is =%.3f \n \n',I
   )

B=u0*(H+I)              //Magnetic flux density
printf(' Magnetic flux density is =%.3f Wb per m^2 \
   n',B)
```

Scilab code Exa 6.18.2 Determine reluctance and current

```
//Chapter-6,Example 6_18_2,Page 6-38
clc()

//Given Values:
u0=4*%pi*10^-7        //Permeability in vacuum
ur=380                //Relative permeability
d=20*10^-2            //diameter of solenoid in m
r=d/2                 //radius of ring in m
```

```
A=5*10^-4              //Crosss sectional area of ring
    in m^2
phi=2*10^-3            //flux in weber
N=200                  //Number of turns

//Calculations:
l=%pi*d                //air gap in the ring
S=(l/(u0*ur*A))        //Reluctance of iron ring
printf('Reluctance of iron ring is =%.2f Amp-turn
    per Wb \n \n',S)

//ohm's law for magnetic circuit is  phi=N*I/S. thus
    ,
I=S*phi/N              //required current
printf(' Current required to obtain given magnetic
    flux is =%.2f Amperes \n',I)
```

Scilab code Exa 6.18.3 Calculate mmf reluctance B and H

```
//Chapter-6,Example 6_18_3,Page 6-39
clc()

//Given Values:
u0=4*%pi*10^-7         //Permeability in vacuum
ur=1                   //Relative permeability of air
r=15*10^-2             //radius of ring in m
A=6*10^-4              //Crosss sectional area of ring
    in m^2
I=4                    //Coil current in amp
N=500                  //Number of turns

//Calculations:
m=N*I                  //MMF of coil
printf('MMF of coil is =%.0f Amp-turn \n \n',m)

```

```
l=2*%pi*r              //air gap
R=(l/(u0*ur*A))        //Reluctance of iron ring
printf(' Reluctance of iron ring is =%.0f Amp-turn per Wb \n \n',R)

phi=m/R                //Magnetic flux
printf(' Magnetic flux is =%.7f Weber \n \n',phi)

B=phi/A                //Magnetic Flux density
printf(' Magnetic flux density is =%.6f Weber per m^2 \n \n',B)

H=B/(u0*ur)            //Magnetic field intensity
printf(' Magnetic field intensity is =%.0f Amperes per m \n \n',H)
```

Scilab code Exa 6.19 Calculate reluctance and mmf

```
//Chapter-6,Example 6_19,Page 6-36
clc()

//Given Values:
u0=4*%pi*10^-7         //Permeability in vacuum
ur=6*10^-3             //Relative permeability of iron
r=0.5                  //radius of ring in m
l=1*10^-2              //air gap in the ring
A=5*10^-4              //Crosss sectional area of ring in m^2
i=5                    //current in ampere
N=900                  //Number of turns

//Calculations:
S=(l/(u0*A))+((2*%pi*r-l)/ur*A)      //Reluctance of iron
printf('Reluctance of iron is =%.2f Amp-turn per Wb
```

```
\n \n',S)

m=N*i                    //mmf produced
printf(' mmf produced is =%.2f Amp-turn \n',m)
```

Scilab code Exa 6.20 Calculate current

```
//Chapter-6,Example 6_20,Page 6-36
clc()

//Given Values:
H=5*10^3                 //coercivity of bar magnet in amp/m
l=10*10^-2               //length of solenoid in m
N=50                     //No of turns

//Calculations:

//We know that, H=NI/l ,hence
I=l*H/N                  //current through solenoid

printf('Current through solenoid is =%.0f Amperes \n',I)
```

Scilab code Exa 6.21 Find magnetic moment

```
//Chapter-6,Example 6_21,Page 6-36
clc()

//Given Values:
ur=1200                 //Relative permeability of medium
V=10^-3                 //volume of iron rod
N=5*10^2                //no of turns per m
```

```
i=0.5                  //current through solenoid in amp

//Calculations:
x=ur-1                 //susceptibility of the ring
H=N*i                  //Magnetisisng field

//We know, x=I/H
I=x*H                  //magnetisation

//Also, I=M/V , thus
M=I*V                  //magnetic moment
printf('Magnetic moment is =%.2f Amp-turn-m^2 \n',M)
```

Scilab code Exa 6.22 Find magnetic moment

```
//Chapter-6,Example 6_22,Page 6-37
clc()

//Given Values:
ur=100                 //Relative permeability of medium
l=0.2                  //length of iron rod
d=10*10^-3             //diameter of solenoid in m
N=300                  //no of turns per m
i=0.5                  //current through solenoid in amp
r=d/2                  //radius of solenoid

//Calculations:
x=ur-1                 //susceptibility of the ring
H=N*i                  //Magnetisisng field

//We know, x=I/H
I=x*H                  //magnetisation

V=%pi*(r^2)*l          //volume of iron rod

```

```
//Also, I=M/V , thus
M=I*V                  //magnetic moment
printf('Magnetic moment is =%.4f Amp-turn-m^2 \n',M)
```

Scilab code Exa 6.23 `Find magnetizing current`

```
//Chapter-6,Example 6_23,Page 6-38
clc()

//Given Values:
l=1.2                  //length of circuit in meter
u=7.3*10^-3            //permeability of silicon sheet
A=100                  //cross sectional area in cm^2
N=150                  //No of turns
B=0.3                  //magmetic field in Wb/m^2

//Calculations:

//We know, B=u*H
H=B/u                  //Magnetic field strength

m=H*l                  //amp-turns in air gap

I1=m/N                 //Required current
printf('Current required to obtain given magnetic
    field is =%.3f Amperes \n \n',I1)

I=I1/A                 //Required current per unit area
printf(' Current required per unit area to obtain
    given magnetic field is =%.6f Amperes \n',I)
```