Scilab Textbook Companion for
Engineering Physics
by S. K. Srivastava and R. A. Yadav[1]

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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.

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Chapter 1

Relativistic Mechanics

Scilab code Exa 1.1 length of the bar

```
1 clc
2 //to calculate length of the bar measured by the
     ststionary observer
3 lo =1  //length in metre
4 v=0.75*3*10^8 //speed (m/s)
5 c=3*10^8 //light speed(m/s)
6 l=lo*sqrt(1-(v^2/c^2))
7 disp(" length of bar in is l="+string(l)+"m")
```

Scilab code Exa 1.2 velocity of rocket

```
1 clc
2 //to calculate velocity of rocket
3 //lo be the length at rest
4 l=99/100 //length is 99 per cent of its length at
     rest is l=(99/100)lo
5 c=3*10^8   //light speed(m/s)
6 v=sqrt(c^2*(1-l^2)) //formula is v=c sqrt(1-(l/lo)
     ^2)
```

```
7 disp("velocity of rocket is v="+string(v)+"m/s")
```

Scilab code Exa 1.4 percentage contraction of rod

```
1  clc
2  //to percentage contraction of a rod
3  c=3*10^8 //light speed(m/s)
4  v=0.8*c //velocity(m/s)
5  //let lo be the length of the rod in the frame in
       which it is at rest
6  //s' is the frame which is moving with a speed 0.8c
       in a direction making an angle 60 with x-axis
7  //components of lo along perpendicular to the
       direction of motion are lo cos60 and lo sin60
       respectively
8  l1=cos(%pi/3)*sqrt(1-(v/c)^2) //length of the rod
       alond the direction of motion =lo cos(pi/3)sqrt
       (1-(v/c)^2)
9  l2=sin(%pi/3)  //length of the rod perpendicular to
       the direction of motion =lo sin60
10 l=sqrt(l1^2+l2^2) // length of the moving rod
11 per=(1-l)*100/1
12 disp("percentage contraction of a rod is per="+
       string(per)+"%")
```

Scilab code Exa 1.7 velocity of circular lamina

```
1  clc
2  //to calculate velocity of the circular lamina
3  c=3*10^8 //light speed (m/s)
4  //R'=R/2 (radius)
5  //R'=R sqrt(1-(v/c)^2)
6  v=(sqrt(3)/2)*c
```

11

```
7 disp("velocity of the circular lamina relative to
      frame s is v="+string(v)+"m/s")
8 //answer is given in terms of c in the textbook
```

Scilab code Exa 1.8 speed of clock

```
1 clc
2 //to calculate speed of the clock
3 //clock should record l=59 minutes for each hour
      recorded by clocks stationary with respect to the
       observer
4 l=59
5 lo=60
6 c=3*10^8 //light speed (m/s)
7 v=sqrt(c^2*(1-l^2/lo^2))
8 disp("speed of the clock is ="+string(v)+"m/s")
```

Scilab code Exa 1.9 distance travelled by beam

```
1 clc
2 //to calculate distance travelled by the beam
3 deltat0=2.5*10^-8 //proper half life of pi mesons in
       (s)
4 c=3*10^8 //light speed (m/s)
5 v=0.8*c //mesons velocity (m/s)
6 deltat=deltat0/sqrt(1-(v/c)^2) //half life (s)
7 //No=initial flux ,N=flux after time t
8 //N=N0 e^(-t/T)
9 //N=N0/e^2 (given)=No e(-t/T)
10 //t=2 deltat
11 d=2*deltat*v //d=vt
12 disp("distance travelled by the beam is d="+string(d
      )+"m")
```

```
13 //answer is given in the textbook=19.96 m
```

Scilab code Exa 1.10 distance travelled by particle

```
1 clc
2 //to calculate distance travelled by the particle
3 deltat0=2*10^-8 //proper half life to of the
     particle in (s)
4 c=3*10^8 //light speed (m/s)
5 v=0.96*c //speed of the particle (m/s)
6 deltat=(deltat0)/(sqrt(1-(v/c)^2)) //half life in
     the laboratory frame t in (s)
7 //t=deltat (flux of the beam falls to (1/2) times
     initial flux)
8 d=v*deltat //d=vt
9 disp("distance travelled by the particle in this
     time is d="+string(d)+"m")
10 //answer is given wrong in the textbook =20.45 m
```

Scilab code Exa 1.11 speed

```
1 clc
2 //to calculate speed
3 deltat0=1440 //proper time interval measured by an
     observer moving with the clock (min)
4 deltat=1444 //time interval measured by a stationary
     observer (min)
5 c=3*10^8 //light speed (m/s)
6 v=c*sqrt(1-(deltat0/deltat)^2)
7 disp(" moving clock appears to lose 4min in 24 hours
     from the stationary observer is v="+string(v)+"m
     /s")
8 //answer is given wrong in the book =2.32*10^7 m/s
```

13

Scilab code Exa 1.12 velocity of beta particle

```
1  clc
2  //to calculate velocity of beta particle
3  c=3*10^8 //light velocity (m/s)
4  u1=0.9*c //velocity of the beta particle relative to
        the atom in the direction of motion
5  v=0.25*c //velocity of the radioactive atom relative
        to an experimenter
6  u=(u1+v)/(1+u1*v/c^2)
7  disp(" velocity of the beta particle as observed by
        the experimenter is u="+string(u)+"m/s")
8  //answer is given in terms of c in the book =0.94c
```

Scilab code Exa 1.13 velocity of B with respect to A

```
1  clc
2  //to calculate velocity
3  c=3*10^8 // light velocity
4  v=0.75*c //speed of A
5  ux=-0.85*c //speed of B
6  ux1=(ux-v)/(1-ux*v/c^2)
7  disp(ux1,'velocity of B with respect to A (m/s) is :
        ')
8  //answer is given in terms of c in the book=-0.9771c
```

Scilab code Exa 1.14 velocity in laboratory frame

```
1  clc
```

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```
2  //to calculate velocity in the laboratory frame
3  c=3*10^8 //light speed (m/s)
4  v=0.8*c //velocity relative to laboratory along
      positive direction of x-axis
5  //given that u'=3 i+4 j+12 k (m/s)
6  ux1=3 //in (m/s)
7  uy1=4 //in (m/s)
8  uz1=12 //in (m/s)
9  ux=(ux1+v)/(1+v*ux1/c^2)
10 uy=(uy1*sqrt(1-(v/c)^2))/(1+v*ux1/c^2)
11 uz=(uz1*sqrt(1-(v/c)^2))/(1+v*ux1/c^2)
12 disp("u=ux i+uy j+uz k")
13 disp("where")
14 disp("ux="+string(ux)+"m/s")
15 disp("uy="+string(uy)+"m/s")
16 disp("uz="+string(uz)+"m/s")
```

Scilab code Exa 1.17 resultant velocity

```
1  clc
2  // to calculate velocity of the particle
3  c=3*10^8 //light speed (m/s)
4  v=0.4*c //velocity of frame s' relative to s along
      axis x
5  ux=0.8*c*(1/2) //component of velocity u(=0.8 c) of
      the particle along x axis ux=0.8 c cos60
6  uy=0.8*c*sin (%pi/3) //component of the velocity u
      of the particle along y axis
7  ux1=(ux-v)/(1-ux*v/c^2)
8  uy1=uy*sqrt(1-(v/c)^2)/(1-(ux*v/c^2))
9  disp("resultant velocity as observed by a person in
      frame s1 is u1=ux1 i+uy1 j")
10 disp("where")
11 disp("ux1="+string(ux1)+"m/s")
12 disp("uy1="+string(uy1)+"m/s")
```

```
13  // answer is given in terms of c in the book i.e. uy1
       =0.756 c m/s
```

Scilab code Exa 1.18 mass and momentum and total energy and kinetic energy

```
1  clc
2  // to calculate mass , momentum , total energy , kinetic
       energy
3  c=3*10^8 // light speed (m/s)
4  v=c/sqrt (2) // velocity (m/s)
5  // let mo be the rest mass of the particle
6  // relativistic mass m of the particle is m=mo/sqrt
       (1-(v/c)^2)
7  m=1/sqrt (1-v^2/c^2) //in kg
8  disp("mass m="+string(m)+" mo")
9  //momentum p of the particle is p=mv
10 p=m*v //in kg-m/s
11 disp("momentum p="+string(p)+" mo")
12 // total energy E of the particle
13 E=m*c^2 //in J
14 disp("energy E="+string(E)+" mo")
15 // kinetic energy K=E-mo c^2
16 K=E-c^2 //in J
17 disp("kinetic energy K="+string(K)+" mo")
18 // answer is given in terms of m0 and c in the book
```

Scilab code Exa 1.19 velocity of particle

```
1  clc
2  // to calculate velocity of the parcticle
3  c=3*10^8 // light speed(m/s)
4  // we know that E(energy)=mc^2
```

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```
5  //  mo=r e s t  mass
6  //E=3  moc^2=mc^2  or  m=3  mo  ( g i v e n  t h a t  t o t a l  energy
        of  the  p a r t i c l e  i s  t h r i c e  i t s  r e s t  energy )
7  m=3  //  r e l a t i v i s t i c  mass
8  // formula  i s  v=c  s q r t ( 1 −(mo/m) ^2)
9  v=sqrt ( c ^2*(1 −(1/m) ^2) )
10 disp ( " v e l o c i t y  of  the  p a r t i c l e  i s  v="+string ( v ) + "m/ s
        " )
```

Scilab code Exa 1.20 mass and speed of an electron

```
1  clc
2  // to  c a l c u l a t e  mass (m) , speed ( v )  of  an  e l e c t r o n
3  K=1.5*10^6*1.6*10^ −19  // k i n e t i c  energy ( J )
4  m0=9.11*10^ −31  // r e s t  mass  of  an  e l e c t r o n ( kg )
5  c=3*10^8  //  v e l o c i t y  of  l i g h t  i n  vacuum(m/ s )
6  m=(K/ c ^2)+m0  // r e l a t i v i s t i c  k i n e t i c  energy ( k=(m−mo) c
        ^2)
7  disp ( " mass  i s  m="+string (m) + " kg  " )
8  v=c*sqrt (1 −m0^2/m^2)
9  disp ( " speed  of  an  e l e c t r o n  i s  v="+string ( v ) + "m/ s " )
```

Scilab code Exa 1.21 work to be done

```
1  clc
2  // to  c a l c u l a t e  work  to  be  done
3  E=0.5*10^6  // r e s t  energy  of  e l e c t r o n  (MeV)  E=m0*c ^2
4  v1=0.6*3*10^8  // speed  of  e l e c t r o n  i n  (m/ s )
5  v2=0.8*3*10^8
6  c=3*10^8  // speed  of  l i g h t  i n  (m/ s )
7  K1=E*((1/ sqrt (1 −v1^2/ c ^2) ) −1)  // k i n e t i c  energy  i n  (
        eV)
8  K2=E*((1/ sqrt (1 −v2^2/ c ^2) ) −1)
```

```
9  w=(K2-K1)*1.6*10^-19
10 disp("amount  of  work  to  be  done  is  w="+string(w)+"J"
      )
```

Scilab code Exa 1.22 speed

```
1  clc
2  //to calculate speed
3  c=3*10^8 //light speed (m/s)
4  m=2.25 //mass m of a body be 2.25 times its rest
      mass mo i.e. m=2.25m0
5  //formula is v=c sqrt(1-(m0/m)^2)
6  v=c*sqrt(1-(1/m)^2)
7  disp(" speed is v="+string(v)+"m/s")
```

Scilab code Exa 1.23 speed of rocket and electron

```
1  clc
2  //to calculate speed of the rocket
3  m0=50 //weight of man on the earth(kg)
4  m=50.5 //weight of man in rocket ship (kg)
5  c=3*10^8 //speed of light(m/s)
6  v=c*sqrt(1-m0^2/m^2)
7  disp("speed of the rocket is v="+string(v)+"m/s" )
8  //to calculate speed of electron
9  m0=9.11*10^-31 //mass of electron =rest mass of
      proton
10 m=1.67*10^-27
11 v=c*sqrt(1-m0^2/m^2)
12 disp("speed of an electron is v="+string(v)+"m/s")
```

Scilab code Exa 1.24 velocity

```
 1  clc
 2  //to calculate velocity
 3  c=3*10^8 //light speed (m/s)
 4  //K(kinetic energy)=(m-mo(rest mass))c^2
 5  //it can also be written as mc^2=K+m0c^2
 6  //given that K=2m0c^2(rest mass energy)
 7  //m=3m0
 8  m=3 //relativistic mass
 9  //formula is v=c sqrt(1-(m0/m)^2)
10  v=c*sqrt(1-(1/m)^2)
11  disp("velocity of a body is v="+string(v)+"m/s")
```

Scilab code Exa 1.25 kinetic energy and momentum of electron

```
 1  clc
 2  //to calculate kinetic energy ,momentum of electron
 3  m0=9.11*10^-31 //its rest mass (kg)
 4  c=3*10^8 //light velocity in (m/s)
 5  m=11*m0 //mass of moving electron is 11 times its
          rest mass
 6  K=(m-m0)*c^2/(1.6*10^-19) // kinetic energy
 7  disp("kinetic energy is K="+string(K)+"eV")
 8  v=c*sqrt(1-(m0/m)^2) //velocity(m/s)
 9  p=m*v //momentum
10  disp("momentum is p="+string(p)+"kg m/s")
```

Scilab code Exa 1.26 proton gain in mass

```
 1  clc
 2  //to calculate proton gain in mass
 3  c=3*10^8 //light speed(m/s)
```

```
4  K=500*10^6*1.6*10^-19 //kinetic energy (J)
5  deltam=K/c^2
6  disp("proton gain in mass is delm="+string(deltam)+"
       kg")
7  //answer is given wrong in the book=8.89*10^28 kg
```

Scilab code Exa 1.27 speed and mass of electron

```
1  clc
2  //to calculate speed of 0.1MeV electron
3  E=0.512*10^6 //rest mass energy E=m0*c^2
4  c=3*10^8 //velocity of light (m/s)
5  K=0.1*10^6 //kinetic energy (MeV)
6  v=c*sqrt(1-(E/(K+E))^2)
7  disp("speed of electron is v="+string(v)+"m/s" )
8  //to calculate mass and speed of 2MeV electron
9  E=2*10^6*1.6*10^-19 //in (J)
10 m=E/c^2
11 disp("mass is m="+string(m)+"kg")
12 m0=9.11*10^-31 //electron mass (kg)
13 v=c*sqrt(1-m0^2/m^2)
14 disp("speed is v="+string(v)+"m/s")
```

Chapter 2

interference

Scilab code Exa 2.2 ratio of intensity

```
1 clc
2 //to calculate ratio of intensity
3 //I1/I2=1/25
4 //formula is a1/a2=sqrt(I1/I2)=1/5
5 a2=5  //a2=5*a1
6 a1=1
7 I=((1+5)^2)/((1-5)^2)
8 disp("ratio of intensity at the maxima and minima in
      the interference pattern is Imax/Imin=((a1+a2)
      ^2)/((a1-a2)^2)="+string(((a1+a2)^2)/((a1-a2)^2))
      +"unitless")
9 //answer is given in terms of ratio
```

Scilab code Exa 2.3 ratio of intensity

```
1 clc
2 //to calculate ratio of intensity at this point to
      that at the centre of a bright fringe
```

```
3 //the intensity at any pont is I=a1^2+a2^2+2*a1*a2*
     cos del
4 //let a1=a2=a
5 //phase difference del is 0
6 //then I0=a^2+a^2+2*a*a*cos 0
7 //we get I0=4a^2
8 I0=4 //intensity
9 //path difference is lemda/8
10 //phase difference =2*%pi/lemda*path difference=%pi
     /4
11 //I1=a^2+a^2+2a*a*cos %pi/4
12 //I1=3.414a^2
13 I1=3.414
14 intensity=I1/I0
15 disp(" ratio of intensity ="+string(intensity)+"
     unitless")
```

Scilab code Exa 2.4 ratio of intensity

```
1 clc
2 //to calculate ratio of maximum intensity to minimum
     intensity
3 //formula is I1/I2=a1^2/a2^2=100/1
4 //a1/a2=10/1
5 a1=10 //a1=10*a2
6 a2=1
7 disp("the ratio of maximum intensity to minmum
     intensity in the interference pattern Imax/Imin
     =((a1+a2)^2)/((a1-a2)^2)="+string(((a1+a2)^2)/((
     a1-a2)^2))+"unitless")
8 //answer is given in terms of ratio in the book
```

Scilab code Exa 2.5 relative intensities

```
1  clc
2  //to calculate relative intensities
3  //Imax/Imin=(a1+a2)^2/(a1-a2)^2+105/95
4  //(a1+a2)/(a1-a2)=1.051
5  //we get a1/a2=40
6  a1=40  //a1=40*a2
7  a2=1
8  disp("the ratio of the intensities of interfering
        sources is I1/I2=a1^2/a2^2="+string(a1^2/a2^2)+"
        unitless")
9  //answer is given in terms of ratio in the book
```

Scilab code Exa 2.7 distance between two coherent sources

```
1  clc
2  //to calculate distance between the two coherent
        sources
3  lambda=5890*10^-10  //wavelength in m
4  omega=9.424*10^-4  //width of the fringes in m
5  D=.80  //distance in m
6  twod=D*lambda/omega
7  disp("the distance between two coherent sources is
        twod="+string(twod)+"m")
```

Scilab code Exa 2.8 fringe width

```
1  clc
2  //to calculate fringe width
3  mu=1.5  //refractive index (unitless)
4  alpha=%pi/180  //refracting angle in radian
5  Y1=20*10^-2  //distance between the source and the
        biprism in m
6  Y2=80*10^-2  //distance in m
```

```
7  D=Y1+Y2 // distance in m
8  lambda=6900*10^-10 //wavelength in m
9  twod=2*(mu-1)*alpha*Y1
10 omega=D*lambda/twod
11 disp("the fringe width is omega="+string(omega)+"m")
```

Scilab code Exa 2.9 wavelength of light

```
1  clc
2  //to calculate wavelength of light
3  omega=1.888*10^-2/20 //in (m)
4  D=1.20 //distance of eye piece from the source in m
5  twod=0.00075 //distance between two virtual sources
      in m
6  lambda=omega*twod/D
7  disp("the wavelength of light is lambda="+string(
      lambda)+"m")
```

Scilab code Exa 2.10 thickness of glass plate

```
1  clc
2  //to calculate thickness of glass plate
3  n=3
4  mu=1.5 //refractive index (unitless)
5  lambda=5450*10^-10 //wavelength in m
6  t=n*lambda/(mu-1)
7  disp("the thickness of glass plate is t="+string(t)+
      "m")
```

Scilab code Exa 2.11 refractive index of sheet

24

```
1  clc
2  // to calculate refractive index of the sheet
3  t =6.3*10^-6 // thickness of thin sheet of transparent
        material in m
4  lambda =5460*10^-10 // wavelength in m
5  n=6
6  mu =( n*lambda/t) +1
7  disp (" the refractive index of the sheet is mu=" +
       string (mu) +" unitless ")
```

Scilab code Exa 2.12 refrctive index of mica

```
1  clc
2  // to calculate refractive index of mica
3  t =1.2*10^-8 // thickness of thin sheet of mica in m
4  n=1
5  lambda =6*10^-7 // wavelength in m
6  mu =( n*lambda/t) +1
7  disp (" the refractive index of mica is mu=" + string (mu
       ) +" unitless ")
8  // answer is given wrong in the book =1.50
```

Scilab code Exa 2.13 intensity and lateral shift

```
1  clc
2  // to calculate intensity
3  mu =1.5 // refractive index ( unitless )
4  t =1.5*10^-6 // thickness of thin glass plate in m
5  pathdifference =( mu -1) *t // in m
6  lambda =5*10^-7 // wavelength in m
7  // del =2*% pi * pathdifference / lambda
8  del =3*% pi
9  a1 =1
```

```
10          //where a1=a2=a
11   a2=1
12   //formula is I=a1^2+a2^2+2*a1*a2*cos del
13   // where cos 3%pi=-1
14   I=a1^2+a2^2+2*a1*a2*(-1)
15   disp("the intensity at the centre of the screen is I
        ="+string(I)+"unitless" )
16   //to calculate lateral shift
17   D=1  //distance in m
18   twod=5*10^-4 //distance between two slits in m
19   mu=1.5 //refractive index (unitless)
20   t=1.5*10^-6 //thickness of thin glass plate in m
21   x0=D*(mu-1)*t/twod
22   disp("the lateral shift of the central maximum is x0
        ="+string(x0)+"m")
```

Scilab code Exa 2.14 spacing between slits

```
1   clc
2   //to calculate spacing between the slits
3   lambda=6*10^-5 //wavelength in cm
4   omegatheta=0.1*%pi/180 //angular width of a fringe
        in radians
5   twod=lambda/omegatheta
6   disp("the spacing between the slits is twod="+string
        (twod)+"cm")
```

Scilab code Exa 2.15 distance

```
1   clc
2   //to calculate distance of the third bright fringe
        on the screen from the central maximum
3   lambda=6.5*10^-5 //wavelength in cm
```

```
4  twod=0.2 //distance between the slits in cm
5  D=120 //distance between the plane of the slits and
       the screen in cm
6  n=3
7  X3=D*n*lambda/twod
8  disp("the distance of the third bright fringe from
       the central maximum is X3="+string(X3)+"cm")
9  //to calculate the least distance from the central
       maximum
10 lambda1=6.5*10^-5 //wavelength in cm
11 lambda2=5.2*10^-5 //wavelength in cm
12 //Xn=Dnlambda1/2d=D(n+1)lambda2/2d
13 //we get,
14 n=lambda2/(lambda1-lambda2)
15 disp("n="+string(n)+" unitless")
16 Xn=D*n*lambda1/twod
17 disp("the distance from the central maximum when the
        bright fringes due to both wavelengths coincide
       is Xn="+string(Xn)+"cm")
```

Scilab code Exa 2.16 refractive index and order and distance and wavelength and fringe width and thickness

```
1  clc
2  //to calculate refractive index
3  D=10 //distance in  cm
4  twod=0.2 //distance detween the slits in cm
5  t=0.05 //thickness of transparent plate in cm
6  deltaX=0.5 //in cm
7  mu=(deltaX*twod/(D*t))+1
8  disp("the refractive index of the transparent plate
       is mu="+string(mu)+" unitless")
9  //to calculate order
10 n=10
11 lambda=7000*10^-8 //wavelength in cm
```

```scilab
12  //path difference =n*lambda
13  n1=n*lambda/(5000*10^-8)
14  disp("the order will be visible is n1="+string(n1)+"
        unitless")
15  //to calculate distance between the two coherent
        sources
16  D=100 //distance in m
17  lambda=6000*10^-8 //wavelength in cm
18  omega=0.05 //distance between two consecutive bright
         fringes on the screen in cm
19  twod=D*lambda/omega
20  disp("the distance between the coherent sources is
        twod="+string(twod)+"cm")
21  //to calculate wavelength
22  Xn=1 //distance of fourth bright fringe from the
        central fringe in cm
23  twod=0.02 //distance between the two coherent
        sources in cm
24  n=4
25  D=100 //distance in cm
26  lambda=Xn*twod/(n*D)
27  disp("the wavelength of light is lambda="+string(
        lambda)+"cm")
28  //to calculate wavelength
29  //position of nth bright fringe from the centre of
        the central fringe is Xn=D*n*lambda/2d——eq(1)
30  //fringe width umega=D*lambda/2d
            ————————————————eq(2)
31  //from eq(1) and eq(2) we get, Xn=n*omega
32  //for 11th bright fringe X11=11*omega
33  //position for nth dark fringe Xn'=(2n+1)D*lambda/4d
34  //X4'=(7/2)*omega
35  //distance between 11th and 4th dark fringe =0.8835
        cm
36  //we get
37  omega=0.1178 //in cm
38  twod=0.05 //distance between slis in cm
39  D=100 // distance in cm
```

```
40  lambda = omega * twod/D
41  disp (" the  wavelength  of  light  is  lambda="+string (
        lambda)+" cm ")
42  // to  calculate  changed  fringe  width
43  //X10-X0=10*omega
44  // given  that  X10-X0=14.73-12.34=2.39mm
45  omega =0.239  // in  mm
46  lambda =6000  // wavelength  in  angstrom
47  lambda1 =5000  // lambda '=5000  angstrom
48  omega1 = omega * lambda1 / lambda
49  disp (" the  changed  fringe  width  is  omega1="+string (
        omega1)+"mm ")
50  // to  calculate  thickness  of  mica  sheet
51  n =3
52  mu =1.6  // refractive  index ( unitless )
53  lambda =5.89*10^-5  // wavelength  in  cm
54  t=n*lambda /( mu -1)
55  disp (" the  thickness  of  mica  sheet  is  t="+string (t)+"
        cm ")
56  // answer  of  thickness  is  given  wrong  in  the  book
        =0.002945  cm
```

Scilab code Exa 2.17 thickness of plate

```
1  clc
2  // to  calculate  the  smallest  thickness  of  the  plate
3  mu =1.5  // refractive  index ( unitless )
4  r =60*% pi /180  // angle  of  refraction  in  radians
5  lambda =5890*10^-10  // wavelength  in  m
6  n =1
7  // formula  is  t=n*lambda /(2* mu * cosr )  where  cosr =0.5
8  t=n*lambda /(2* mu *0.5)
9  disp (" the  smallest  thickness  of  the  plate  which  will
          appear  dark  by  reflection  is  t="+string (t)+"m")
```

Scilab code Exa 2.18 least thickness

```scilab
1  clc
2  //to calculate least thickness of the film
3  lambda=5893*10^-10//wavelength in m
4  r=0 //in degree
5  mu=1.42 //refractive index
6  n=1
7  //the formula is t=n*lambda/(2*mu*cosr), where cos0
       =1
8  t=n*lambda/(2*mu*1)
9  disp("the least thickness of the film that will
       appear black is t="+string(t)+"m")
10 t=(2*n-1)*lambda/(2*mu*1*2)
11 disp("the least thickness of the film that will
       appear bright is t="+string(t)+"m")
```

Scilab code Exa 2.19 thickness of film

```scilab
1  clc
2  //to calculate thickness of the film
3  lambda1=6.1*10^-7 //wavelength in m
4  lambda2=6*10^-7 // wavelength in m
5  //the two dark consecutive fringes are overlapping
       for the wavelength lambda1 and lambda2
       respectively
6  //then, n*lambda1=(n+1)*lambda2
7  //we get,
8  n=lambda2/(lambda1-lambda2)
9  sini=4/5
10 mu=4/3
11 //formula is mu=sini/sinr
```

30

```
12  sinr =0.6
13  cosr=sqrt (1-( sinr )^2)
14  t=n*lambda1 /(2*mu*cosr)
15  disp (" the thickness of the film is t="+string (t)+"m"
       )
```

Scilab code Exa 2.20 thickness of film

```
1   clc
2   //to calculate thickness of the film
3   mu =1.33 // refractive index of soap film ( unitless )
4   i =45*%pi /180
5   //the formula is mu=sini/sinr
6   sinr =0.5317
7   cosr=sqrt (1-( sinr )^2)
8   //for destructive interference
9   lambda =5890*10^-10 // wavelength in m
10  n=1
11  t=n*lambda /(2*mu*cosr)
12  disp (" the thickness of the film is t="+string (t)+"m"
       )
```

Scilab code Exa 2.21 angle of wedge

```
1   clc
2   //to calculate angle of the wedge
3   lambda =6000*10^-10 // wavelength in m
4   mu =1.4 // refractive index in unitless
5   omega =2*10^-3 // distance in m
6   theta=lambda /(2*mu*omega)
7   disp (" the angle of the wedge is theta ="+string (
       theta)+" radians ")
```

Scilab code Exa 2.22 wavelength of light

```
1 clc
2 //to calculate wavelength of light
3 theta=10*%pi/(60*60*180) //angle of wedge in radians
4 omega=5*10^-3 //distance between the successive
      fringes in cm
5 mu=1.4 //refractive index
6 lambda=2*mu*theta*omega
7 disp("the wavelength of light is lambda="+string(
      lambda)+"m")
```

Scilab code Exa 2.23 wavelength of light

```
1 clc
2 //to calculate wavelength of the light
3 D15=0.590*10^-2 //diamater of 15th ring in m
4 D5=0.336*10^-2 //diameter of 5th ring in m
5 p=10
6 R=1 //radius of plano convex lens in m
7 //formula is lambda=Dn+p^2-Dn^2/4pR
8 lambda=((D15^2)-(D5^2))/(4*p*R)
9 disp("the wavelength of the monochromatic light is
      lambda="+string(lambda)+"m")
```

Scilab code Exa 2.24 refractive index of liquid

```
1 clc
2 //to calculate refractive index of the liquid
```

```scilab
3  n=6
4  lambda=6000*10^-10 //wavelength in m
5  R=1 //radius of curvature of the curved surface in m
6  Dn=3.1*10^-3 //diameter of 6th bright ring in m
7  mu=2*(2*n-1)*lambda*R/Dn^2
8  disp("the refractive index of the liquid is mu="+
       string(mu)+"unitless")
```

Scilab code Exa 2.25 radius and thickness

```scilab
1  clc
2  //to calculate radius of curvature
3  lambda=5900*10^-10 //wavelength in m
4  n=10
5  Dn=5*10^-3 // diameter of 10th dark ring in m
6  R=Dn^2/(4*n*lambda)
7  disp("the radius of curvature of the lens is R="+
       string(R)+"m")
8  //to calculate thichness
9  t=n*lambda/2
10 disp("the thickness of the air film is t="+string(t)
       +"m")
```

Scilab code Exa 2.26 distance

```scilab
1  clc
2  //to calculate the distance from the apex of the
       wedge at which the maximum due to the two
       wavelengths first coincide
3  //condition for maxima for normal incidence air film
        is  2t=(2n+1)lambda/2
4  //let nth order maximum due to lambda1 coincides
       with (n+1)th order maximum due to lambda2
```

```
5  //we get , n=(3lambda2−lambda1)/2(lambda1−lambda2)
6  // we also get, 2t=lambda1*lambda2/(lambda1−lambda2)
7  //t=X*theta
8  lambda1=5896*10^-8 //wavelength in cm
9  lambda2=5890*10^-8 //wavelength in cm
10 theta=0.3*%pi/180 //angle of wedge
11 X=lambda1*lambda2/(2*(lambda1-lambda2)*theta)
12 disp("the distance from the apex of the wedge is X="
      +string(X)+"cm")
```

Scilab code Exa 2.27 radius and thickness

```
1  clc
2  //to calculate radius of curvature
3  n=10
4  Dn=0.50 //diameter of 10th ring in cm
5  lambda=6000*10^-8 //wavelength in cm
6  R=Dn^2/(4*n*lambda)
7  disp("the radius of curvature of the lens is R="+
      string(R)+"cm")
8  //answer is given wrong in the book =106 cm
9  //to calculate thickness of the film
10 t=Dn^2/(8*R)
11 disp("the thickness of the film is t="+string(t)+"cm
      ")
```

Scilab code Exa 2.28 diameter of ring

```
1  clc
2  //to calculate diameter
3  //the difference of (n+p)th and nth dark ring is Dn+
      p^2−Dn^2=4nRlambda
4  N=12 //where N=n+p
```

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```
5  n=4
6  D12=0.7  //diameter of 12th dark ring in cm
7  D4=0.4  //diameter of 4th dark ring in cm
8  //D12^2−D4^2=4pRlambda where p=8 −−−−eq(1)
9  //D20^2−D4^2=4pRlambda where p=16 −−−−−eq(2)
10 //divide eq(2) by eq(1) ,we get
11 D20=sqrt((2*D12^2)-D4^2)
12 disp("the diameter of 20th dark ring is D20="+string
       (D20)+"cm")
```

Scilab code Exa 2.29 diameter of ring

```
1  clc
2  //to calculate diameter
3  lambda1=6*10^-5  //wavelength in cm
4  lambda2=4.5*10^-5  //wavelength in cm
5  R=90  //radius of curvature of the curved surface in
       cm
6  //Dn^2=4nRlambda1 −−−−−−−eq(1)
7  //Dn+1^2=4(n+1)Rlambda2−−−−−−−eq(2)
8  //the nth dark ring due to lambda1 coincides with (n
       +1)th dark ring due to lambda2
9  //from eq(1) and eq(2)−4nRlambda1=4(n+1)Rlambda2
10 // we get ,
11 n=lambda2/(lambda1-lambda2)
12 Dn=sqrt(4*n*R*lambda1)
13 disp("the diameter of nth dark ring for lambda1 is
       Dn="+string(Dn)+"cm")
```

Scilab code Exa 2.30 difference of square of diameters

```
1  clc
```

```scilab
2  //to calculate the difference of square of diameters
        for nth and (n+p)th ring when light of
      wavelength lambda is changed to lambda'
3  lambda=6*10^-5 //wavelength in cm
4  lambda1=4.5*10^-5 //wavelength in cm
5  //Let D=(D^2-Dn^2)=0.125 cm^2
6  D=0.125
7  //formula is D'(n+p)^2-D'n^2=lambda'*(D(n+p)^2-Dn^2)
      /lambda
8  disp("the difference of square of diameters is D1(n+
      p)^2-D1n^2=(lambda1*D)/lambda="+string((lambda1*D
      )/lambda)+"cm^2")
9  //to calculate difference of square of diamaters
      when liqquid of refractive index mu' is
      introduced
10 mu=1 //refractive index (unitless)
11 mu1=1.33 // mu'=1.33
12 //formula is D'(n+p)^2-D'n^2=(mu/mu')*(D(n+p)^2-Dn
      ^2)
13 disp("the difference of square of diameters is D1(n+
      p)^2-D1n^2=(mu*D)/mu1="+string((mu*D)/mu1)+"cm^2"
      )
14 //to calculate difference of square of diameters
      when radius of curvature of convex surface of the
       plano convex lens is doubled
15 R1=2 //radius of curvature is R'=2R
16 R=1
17 //formula is D'(n+p)^2-D'n^2=(R'/R)*(D(n+p)^2-Dn^2)
18 disp("the difference of square of diameters is D1(n+
      p)^2-D1n^2=(R1*D)/R="+string((R1*D)/R)+"cm^2")
```

Chapter 3

Diffraction

Scilab code Exa 3.1 angular width and linear width

```
1  clc
2  //to calculate angular width and linear width
3  lambda=6*10^-5
4  e=0.01 //width of slit in cm
5  //position of minima is given by
6  sintheta=lambda/e                    //sintheta=m*lambda/
      e              ,where m=1,2,3,......
7  disp("sintheta="+string(sintheta)+" m")
8  //since theta is very small,so sintheta is
      approximately equal to theta
9  theta=sintheta
10 theta1=2*theta
11 disp("total angular width of central maximum is
      theta1="+string(theta1)+" m radians ")
12 d=100  //distance in cm
13 Y=theta*d
14 Y1=2*Y
15 disp("linear width of central maximum on the screen
      is Y1="+string(Y1)+" m cm")
16 disp("values of m =1,2,3,............ gives the
      directions of first, second .............minima")
```

Scilab code Exa 3.2 wavelength of light

```
1  clc
2  //to calculate wavelength of light
3  //in a diffraction pattern due to single slit,
       minima is given by e*sintheta=m*lambda
4  //since theta is very small, sintheta is
       approximately equal to theta
5  //theta=Y/d
6  e=0.014 //width of slit in cm
7  d=200 //distance in cm
8  m=2
9  Y=1.6 //in cm
10 lambda=Y*e/(d*m)
11 disp("wavelength of light is lambda="+string(lambda)
       +"cm")
```

Scilab code Exa 3.3 width of slit

```
1  clc
2  //to calculate width of slit
3  //direction of minima in fraunhofer diffraction due
       to single slit is given by %pi/lambda*e*siuntheta
       =+m*%pi,where m=1,2,3
4  //angular spread of the central maximum on either
       side of the incident light is sintheta=lambda/e,
       where m=1,position of first minima
5  lambda=5000*10^-8
6  e=lambda/sin(%pi/6)
7  disp("width of slit is e="+string(e)+"cm")
```

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Scilab code Exa 3.4 wavelength of incident light

```
1  clc
2  // to calculate wavelength of incident light
3  // direction of minima is given by e*sintheta=+m*
      lambda
4  // for first minima m=1, i.e. e*sintheta=lambda,
      sintheta is approximately equal to theta, then we
      can write it as e*theta=lambda ........... eq(1)
5  // theta=Y/d ....................... eq(2)
6  e=0.02 // in cm
7  Y=0.5           // position of first minima from the
      central maxima in cm
8  d=200               // distance of screen from the slit
      in cm
9  // from eq(1) and eq(2), we get
10 lambda=e*Y/d
11 disp("wavelength of incident light is lambda="+
      string(lambda)+"cm")
```

Scilab code Exa 3.6 values of lambda1 and lambda2

```
1  clc
2  // to calculate values of lambda1 and lambda2
3  // in fraunhofer diffraction pattern, the direction
      of minima is given by e*sintheta=+m*lambda, where
      m=1,2,......
4  // direction of fourth minima (m=4) for wavelength
      lambda1 is given by e*sintheta1=4*lambda1
      .......... eq(1)
5  // similarly, e*sintheta2=5*lambda2 .......... eq(2)
```

```
6  //from eq(1) and eq(2),we get e*sintheta=4*lambda1
      =5*lambda2 .... eq(3)
7  y=0.5               //in cm
8  f=100               //in cm
9  theta=y/f                   //in radian
10 sintheta=theta //theta is very small
11 e=0.05        //width of slit in cm
12 lambda1=e*sintheta/4
13 disp("lambda1="+string(lambda1)+"cm")
14 //from eq(3) we get,
15 lambda2=4*lambda1/5
16 disp("lambda2="+string(lambda2)+"cm")
```

Scilab code Exa 3.7 half angular width

```
1  clc
2  //to calculate half angular width
3  e=1.2*10^-4            //width of slit in cm
4  y=6*10^-5      //wavelength of monochromatic light
      in cm
5  theta=y/e
6  disp("half angular width of central bright maxima is
       theta="+string(theta)+"radian")
```

Scilab code Exa 3.8 angle

```
1  clc
2  //to calculate angle
3  lambda=6000*10^-8       //wavelength of light in cm
4  e=0.03        //width of slit in cm
5  //e*sintheta=m*lambda,where m=1
6  theta=asind(lambda/e)
```

```
7  disp("angle at which the first dark band are formed
       in the fraunhofer diffraction pattern is theta="+
       string(theta)+"degree")
8  theta1=asind(3*lambda/(2*e))
9  disp("angle at which the next bright band are formed
        in the fraunhofer diffraction pattern is theta1=
       "+string(theta1)+"degree")
```

Scilab code Exa 3.9 distances

```
1  clc
2  //to calculate distances of first dark band and of
       next bright band on either side of the central
       maximum
3  //formula is e*sintheta=m*lambda,where m=1
4  lambda=5890*10^-8      //wavelength of light in cm
5  e=0.03 //width of slit in cm
6  sintheta=lambda/e
7  theta=sintheta //becoz theta is very small,so
       sintheta is approximately equal to theta
8  f=50
9  y=f*theta
10 disp("linear distance of first minimum from the
       central maximum is y="+string(y)+"cm")
11 sintheta1=3*lambda/(2*e)
12 theta1=sintheta1
13 y1=f*theta1
14 disp("linear distance of first secondary maxima is
       y1="+string(y1)+"cm")
```

Scilab code Exa 3.10 wavelength of light and missing orders

```
1  clc
```

```
2  //to calculate wavelength of light and missing
      orders
3  omega=0.25   //fringe width in cm
4  D=170 //distance in cm
5  twod=0.04 // distance in cm
6  lambda=omega*twod/D
7  disp("wavelength of light is lambda="+string(lambda)
      +"cm")
8  e=0.08 //width of slit in mm
9  d=0.4 //in mm
10 m=1
11 n=m*(e+d)/e
12 disp("missing order is n="+string(n)+" unitless")
13 //we can also find order for m=2,3,....
```

Scilab code Exa 3.11 wavelength of spectral line

```
1  clc
2  //to calculate wavelength
3  n=2 //order of spectrum
4  theta=%pi/6 //in radians
5  E=1/5000 //let (e+d)=E
6  lambda=E*sin(%pi/6)/n
7  disp("the wavelength of the spectral line is lambda=
      "+string(lambda)+"cm")
```

Scilab code Exa 3.12 difference in deviations

```
1  clc
2  //to calculate difference in deviations
3  lambda=5*10^-5     //wavelength of light in cm
4  eplusd=1/6000           //where eplusd=e+d
```

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```
5  theta1 = asind ( lambda / eplusd )     // for first order
       spectrum
6  theta3 = asind (3* lambda / eplusd ) // for second order
       spectrum
7  difference = theta3 - theta1
8  disp (" difference in deviations in first and third
       order spectra is difference ="+ string ( difference )
       +" degree ")
```

Scilab code Exa 3.13 orders

```
1  clc
2  // to calculate orders
3  // let E=(e+d)
4  // formula is (e+d)*sin thita=n*lambda
5  // for maximum order to be possible thita=90 degree
6  // sin theta=1
7  E =2.54/2620 // in cm
8  lambda =5*10^ -5 // wavelength of the incident light in
       cm
9  n = E / lambda
10 disp (" the orders will be visible is n="+ string ( n )+"
       unitless ")
```

Scilab code Exa 3.14 number of lines per cm

```
1  clc
2  // to calculate number of lines in the grating
3  // theta1=theta2=30 degree
4  // sin theta1=sin theta2=1/2
5  lambda1 =6*10^ -5
6                             // wavelength in cm
7  lambda2 =4.5*10^ -5
```

```
8  // let (e+d)=E
9  // formula is (e+d)*sin theta1=n*lambda1------------eq
   (1)
10 // (e+d)*sin theta2=(n+1)*lambda2-----------eq(2)
11 // we get ,
12 n=lambda2/(lambda1-lambda2)  // order of spectrum
13 E=n*lambda1/sin(%pi/6)
14 number=1/E
15 disp("number of lines is number="+string(number)+"
   unitless")
```

Scilab code Exa 3.15 orders of spectrum

```
1  clc
2  // to calculate order when visible light of
   wavelength in the range 4000 to 7500 angstrom
3  // let E=(e+d)
4  E=1/4000 // in cm
5  lambda1=4*10^-5
6                              // wavelength in cm
7  lambda2=7.5*10^-5
8  n1=E*sin(%pi/2)/lambda1
9  n2=E*sin(%pi/2)/lambda2
10 disp("order when wavelength of 4000 angstrom is n1="
   +string(n1)+" unitless")
11 disp("order when wavelength of 7500 angstrom is n2="
   +string(n2)+" unitless")
```

Scilab code Exa 3.17 angle of diffraction

```
1  clc
2  // to calculate angle of diffraction
3  n=1 // order
```

```
4  lambda=5000*10^-8              //wavelength of light
      in cm
5  eplusd=1/5000        // in cm
6  theta=asind(n*lambda/(eplusd))
7  disp("angle of diffraction for maximum intensity in
      the first order is theta="+string(theta)+"degree"
      )
```

Scilab code Exa 3.18 number of lines in one centimeter

```
1  clc
2  //to calculate number of lines in one centimeter of
      the grating
3  //let E=(e+d)
4  //formula for grating equation for principal maxima
      is (e+d)*sin theta=n*lambda
5  n=2 //order of spectrum
6  lambda=5*10^-5 //wavelength in cm
7  E=n*lambda/sin(%pi/6)
8  number=1/E
9  disp("number of lines is number="+string(number)+"
      unitless")
10 //answer is given wrong in the book ,number of lines
      =1000
```

Scilab code Exa 3.19 spectral line

```
1  clc
2  //to calculate which spectral line in 5th order will
       overlap with 4th order line of 5890 angstrom
3  //the grating equation for principal maxima is (e+d)
      *sin theta =n*lambda
4  n1=5
```

```
5                      //order of spectrum
6  n2=4
7  lambda2=5890*10^-8 //wavelength of 4th order
       spectrum in cm
8  //(e+d)*sin theta=5*lambda——————————eq(1)
9  //(e+d)*sin theta=4*5890*10^−8−−−−−−−−−−−−−−−−eq(2)
10 //from eq(1) and eq(2) ,we get
11 lambda1=n2*lambda2/n1
12 disp("wavelength of 5th order spectrum is lambda1="+
       string(lambda1)+"cm")
```

Scilab code Exa 3.20 grating element

```
1  clc
2  //to calculate grating element
3  //grating equation for principal maxima is given by
       (e+d)*sintheta=n*lambda
4  //let nth order spectrum for yellow line (lambda
       =6000 angstrom) coincide with (n+1)th order
       spectrum for blue line (lambda=4800 angstrom)
5  //(e+d)*sintheta=n*6000*10^−8..eq(1)
6  //(e+d)*sintheta=(n+1)*4800*10^−8.....eq(2)
7  //from eq(1) and eq(2),we get n=4
8  n=4
9  lambda=6000*10^-8        //wavelength in cm
10 sintheta=3/4
11 eplusd=n*lambda/sintheta
12 disp("grating element is eplusd="+string(eplusd)+"cm
       ")
```

Scilab code Exa 3.21 angle of diffraction and absent spectra

```
1  clc
```

```
2 //to calculate angle of diffraction for third order
      spectrum and absent spectra if any
3 n=3
4 lambda=6000*10^-8
5 eplusd=1/200
6 theta=asind(n*lambda/eplusd)
7 disp("angle of refraction is theta="+string(theta)+"
      degree")
8 d=0.0025
9 e=eplusd-d //width of wire in cm
10 m=1
11 n=eplusd*m/e
12 disp("order of absent spectrum is n="+string(n)+"
      unitless")
13 disp("here,m=1 is considered because the higher
      values of m result the order of absent spectrum
      more than the given order 3")
```

Scilab code Exa 3.22 difference in two wavelenghts

```
1 clc
2 //to calculate difference in the two wavelengths
3 //grating equation for principal maxima is (e+d)*
      sintheta=n*lambda ............... eq(1)
4 //differentiate both sides ,we get dtheta=n*dlambda
      /((e+d)*costheta) ........... eq(2)
5 lambda=5000            //mean value of wavelengths in
       angstrom
6 cottheta=1.732        //cot30degree=1.732
7 dtheta=0.01 //in radian
8 //put the value of n from eq(2),we can write eq(2)
9 dlambda=lambda*dtheta*cottheta
10 disp("difference in two wavelengths is dlambda="+
       string(dlambda)+"angstrom")
```

Scilab code Exa 3.23 dispersive power

```
1  clc
2  //to calculate dispersive power
3  //differentiate grating equation ,we get dtheta/
       dlambda=n/((e+d)*costheta)
4  n=2 //order
5  eplusd=1/4000
6  lambda=5000*10^-8 //wavelength in cm
7  sintheta=n*lambda/(eplusd)
8  costheta=sqrt(1-(sintheta)^2)
9  dtheta=n/((eplusd)*costheta)    //where dispersive
       power dtheta/dlambda=dtheta
10 disp("dispersive power of he grating in the second
       order spectrum is dtheta="+string(dtheta)+"
       unitless")
```

Scilab code Exa 3.24 orders

```
1  clc
2  //to calculate orders
3  eplusd=1/4000
4  lambda1=5*10^-5
5                                //wavelengh in cm
6  lambda2=7.5*10^-5
7  nmax1=eplusd/lambda1
8  nmax2=eplusd/lambda2
9  disp("orders will be observed by a grating ,if it is
        illuminated by light of wavelength of 5000
       angstrom is nmax1="+string(nmax1)+"unitless ")
10 disp("orders will be observed ,if it is illuminated
       by light of wavelength of 7500 angstrom is nmax2
```

=’+ string (nmax2)+” unitless ”)

Scilab code Exa 3.25 difference in wavelenghts

```
1 clc
2 //to calculate difference in wavelengths of two
     lines
3 //let E=(e+d)=1/5000
4 //we get
5 E=2*10^-4 //in cm
6 n=2 //order of spectrum
7 lambda=5893*10^-8 //wavelength in cm
8 //dtheta=2.5'=(2.5/60)*(3.14/180),we get
9 dtheta=7.27*10^-4 //in radian
10 dlambda=sqrt(((E/n)^2)-lambda^2)*dtheta
11 disp("the difference in wavelengths of two lines is
     dlambda="+string(dlambda)+"cm")
```

Scilab code Exa 3.26 aperture

```
1 clc
2 //to calculate aperture of the objective of a
     telescope
3 lambda=6*10^-5 //wavelength of light in cm
4 dtheta=4.88*10^-6 // in radians
5 a=1.22*lambda/dtheta
6 disp("the aperture of the objective of a telescope
     is a="+string(a)+"cm")
```

Scilab code Exa 3.27 separation of two points on the moon

```
1 clc
2 //to calculate separation of two points on the moon
3 lambda=5.5*10^-5 //wavelength of light in cm
4 a=500 //diameter in cm
5 dtheta=1.22*lambda/a //limit of resolution of
      telescope in radians
6 R=3.8*10^8 //distance between earth and moon in m
7 X=R*dtheta
8 disp("the separation of two points on the moon is X=
      "+string(X)+"m")
```

Scilab code Exa 3.28 numerical aperture

```
1 clc
2 //to calculate numerical aperture of the objective
3 lambda=5.461*10^-5 //wavelength in cm
4 S=5.55*10^-5 //distance in cm
5 NA=1.22*lambda/(2*S)
6 disp("the numerical aperture of the objective is NA=
      "+string(NA)+"unitless")
```

Scilab code Exa 3.29 resolving power

```
1 clc
2 //to calculate resolving power of microscope
3 NA=0.12 //numerical aperture
4 lambda=6*10^-5 //wavelength of light in cm
5 RP=2*NA/lambda //RP=resolving power
6 disp("the resolving power of microscope is RP="+
      string(RP)+"unitless")
```

Scilab code Exa 3.30 maximum resolving power

```
1  clc
2  //to calculate maximum resolving power
3  lambda=5*10^-5 //wavelength of light in cm
4  N=40000 //total number of lines on grating
5  //(e+d)=12.5*10^-5 cm
6  //formula is nmax=(e+d)/lambda
7  //we get
8  nmax=2 //order of spectrum
9  RP=nmax*N //RP=resolving power
10 disp("the maximum resolving power is RP="+string(RP)
       +"unitless")
```

Scilab code Exa 3.31 minimum number of lines

```
1  clc
2  //to calculate minimum number of lines in a grating
3  lambda1=5890
4                //wavelengh in angstrom
5  lambda2=5896
6  dlambda=6 //smallest wavelength difference in
       angstrom
7  n=2 //order of spectrum
8  lambda=(lambda1+lambda2)/2 //average wavelength in
       angstrom
9  RP=lambda/dlambda //RP=resolving power
10 N=RP/n
11 disp("minimum number of lines in a grating is N="+
       string(N)+"unitless")
```

Scilab code Exa 3.32 will the telescope be able to observe the wiremesh

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```
1  clc
2  //will the telescope be able to observe the wiremesh
3  a=3 //aperture in cm
4  lambda=5.5*10^-5 //wavelength of light in cm
5  //limit of resolution of telescope is given by
6  theta=1.22*lambda/a
7  //alpha=spacing of wire-mesh/distance of objective
        from wire-mesh
8  alpha=0.2/(80*10^2)
9  disp("theta="+string(theta)+"radian")
10 disp("alpha="+string(alpha)+"radian")
11 disp("if alpha>theta then telescope will be able to
        observe the wire-mesh")
12 //value of alpha is given wrong in the book
        2.25*10^-5 radian
```

Scilab code Exa 3.33 distance between the centres of the images of two stars

```
1  clc
2  //distance between the centres of  images of two
        stars
3  lambda=5500*10^-8            //wavelength of light in
        cm
4  f=4*10^2                    //focal length of telescope
        objective in cm
5  a=0.01*10^2         //diameter in cm
6  X=1.22*lambda*f/a
7  disp("distance between the centres of images of two
        stars is X="+string(X)+"cm ")
```

Scilab code Exa 3.34 diameter of a telescope objective

```
1  clc
2  //to calculate diameter of a telescope
3  lambda=5*10^-5 //wavelength in cm
4  theta=(%pi/180)*(1/1000) //in radians
5  a=1.22*lambda/theta
6  disp("the diameter of a telescope is a="+string(a)+"
      cm")
```

Scilab code Exa 3.35 smallest angle between two stars

```
1  clc
2  //to calculate smallest angle between two stars
3  lambda=5*10^-5 //wavelength in cm
4  a=100*2.54 //diameter in cm
5  theta=1.22*lambda/a
6  disp("the smallest angle between two stars is thita=
      "+string(theta)+"radians")
```

Scilab code Exa 3.36 limit of resolution of telescope

```
1  clc
2  //to calculate limit of resolution of the telescope
3  lambda=5890*10^-8 //wavelength in cm
4  a=1 //diameter in cm
5  theta=1.22*lambda/a
6  disp("the limit of resolution of the telescope is
      theta="+string(theta)+"radians ")
```

Scilab code Exa 3.37 resolving limit of microscope

```
1  clc
2  //to calculate resolving limit of microscope
3  lambda=5.5*10^-5 //wavelengh in cm
4  theta=%pi/6 //in radians
5  s=1.22*lambda/(2*sin(%pi/6))
6  disp("resolving limit of microscope is s="+string(s)
       +"cm")
```

Scilab code Exa 3.38 resolving power of grating and smallest wavelength difference

```
1  clc
2  //to calculate resolving power of grating
3  N=15000 //total number of lines on grating
4  lambda=6*10^-5 //wavelength in cm
5  n=2 //order of spectrum
6  RP=n*N
7  disp("resolving power is RP ="+string(RP)+"unitless"
       )
8  //to calculate smallest wavelength difference that
       can be resolved with a light of wavelength 6000
       angstrom in the second order
9  dlambda=lambda/(n*N)
10 disp("smallest wavelength difference dlambda="+
       string(dlambda)+"cm")
```

Scilab code Exa 3.39 resolving power and smallest wavelength

```
1  clc
2  //to calculate resolving power in the second order
3  N=6*10^4 //N=total number of lines on grating
4  n=2 //order of spectrum
5  RP=n*N //RP=resoling power
```

```
 6  disp(" the  resolving  power  is  RP="+string(RP)+"
        unitless")
 7  //to  calculate  smallest  wavelength
 8  lambda=6000*10^-8  //wavelength  in  cm
 9  n=3  //order  of  spectrum
10  dlambda=lambda/(n*N)
11  disp(" smallest  wavelength  that  can  be  resolved  in
        the  third  order  in  6000 angstrom  wavelength  region
         is  dlambda="+string(dlambda)+"cm")
```

Chapter 4

Polarisation

Scilab code Exa 4.1 compare intensities

```
1  clc
2  // compare the intensities of ordinary and
       extraordinary rays
3  //intensity of ordinary rays is given by Io=a^2 *(
       sin theta)^2
4  //where theta=30 degree
5  //we get Io=a^2/4
6  Io=1/4
7  //intensity of extraordinary ray is given by IE=(a*
       cos theta)^2
8  //we get IE=3*a^2/4
9  IE=3/4
10 I=IE/Io
11 disp("the intensities of ordinary and extraordinary
       rays is I="+string(I)+" unitless")
```

Scilab code Exa 4.2 angle of refraction

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```
1 clc
2 //to calculate angle of refraction
3 //according to brewster's law  mu=tan ip
4 mu=1.732   //refractive index
5 ip=atand(mu)    //polarising angle in degree
6 r=90-ip
7 disp("angle of refraction of ray is r="+string(r)+"
      degree")
```

Scilab code Exa 4.3 polarising angle and angle of refraction

```
1 clc
2 //to calculate polarising angle and angle of
      refraction
3 mu=1.345     //refractive index, mu=1/sinc=1/
      sin48degree=1/0.7431
4 ip=atand(mu)
5 r=90-ip
6 disp("polarising angle is ip="+string(ip)+"degree")
7 disp("angle of refraction is r="+string(r)+"degree")
```

Scilab code Exa 4.4 thickness of half wave plate

```
1 clc
2 //to calculate thickness of a half wave plate of
      quartz
3 lambda=5*10^-5 //wavelength in cm
4 mue=1.553
5              //refractive index (unitless)
6 muo=1.544
7 //for a half plate of positive crystal
8 t=lambda/(2*(mue-muo))
```

```
9 disp(" thickness of a half wave plate of quartz is t=
   "+string(t)+"cm")
```

Scilab code Exa 4.5 thickness of quarter wave plate

```
1 clc
2 //to calculate thickness of quarter wave plate
3 lambda=5.890*10^-5 //wavelength of light in cm
4 mue=1.553
5                  //refractive index
6 muo=1.544
7 t=lambda/(4*(mue-muo))
8 disp(" thickness of quarter wave plate is t="+string(
   t)+"cm")
```

Scilab code Exa 4.6 thickness of doubly refracting plate

```
1 clc
2 //to calculate thickness of a doubly refracting
    plate
3 lambda=5.890*10^-5 //wavelength in cm
4 muo=1.53
5                  //refractive index
6 mue=1.54
7 t=lambda/(4*(mue-muo))
8 disp(" thickness of a plate is t="+string(t)+"cm")
```

Scilab code Exa 4.7 angle of rotation

```
1 clc
```

```
2 // to calculate angle of rotation
3 alpha=66 // specific rotation of cane sugar in degree
4 c=15/100 // concentration of the solution in gm/cc
5 l=20 // length of tube in cm
6 theta=alpha*l*c/10
7 disp("the angle of rotation of the plane of
    polarisation is theta="+string(theta)+"degree")
```

Scilab code Exa 4.8 specific rotation

```
1 clc
2 // to calculate specific rotation
3 theta=26.4 // in degree
4 l=20 // length in cm
5 c=0.2 //gm/cm^3
6 alpha=10*theta/(l*c)
7 disp("the specific rotation is alpha="+string(alpha)
    +"degree")
```

Scilab code Exa 4.9 strength of solution

```
1 clc
2 // to calculate strength of solution
3 theta=11 // degree
4 l=20 // length in cm
5 alpha=66 // specific rotation of sugar in degree
6 c=10*theta/(l*alpha)
7 disp("strength of solution is c="+string(c)+"gm/cm^3
    ")
```

Scilab code Exa 4.10 difference in the refractive indices

```
1  clc
2  //to calculate difference in the refractive indices
3  //specific rotation is theta/d=29.73 degree/mm
4  theta=29.73 //where theta=theta/d
5  lambda=5.086*10^-4 //wavelength in mm
6  //optical rotation is given by theta=%pi*d*(mul-mur)
       /lambda
7  //where mul and mur are refractive indices for anti-
       clockwise and clockwise polarised lights
8  mu=theta*lambda/180 //where mu=mul-mur
9  disp("difference in refractive indices is mu="+
       string(mu)+" unitless")
```

Scilab code Exa 4.11 optical rotation

```
1  clc
2  //to calculate optical rotation
3  //let theta' be the optical rotation by a solution
       of strength c' in a tube of length l' then
4  //we get 10*theta'/l'*c'=10*theta/l*c
5  c=1/3 //it is given that solution is 1/3 of its
       previous concentration i.e. c'/c=1/3,where c=c'/c
6  l1=30   //where l1=l'
7              //length in cm
8  l=20
9  theta=13 //degree
10 //formula is theta'=l'*c'*theta/(l*c)
11 theta1=l1*c*theta/l
12 disp("optical rotation is theta1="+string(theta1)+"
       degree")
```

Scilab code Exa 4.12 specific rotation

```
1  clc
2  //to calculate specific rotation
3  theta =52.8 //optical rotation in degree
4  l=20 //length of the solution in cm
5  c=20/50 //concentration of the solution in gm/cc
6  alpha =10* theta /(l*c)
7  disp("the specific rotation is alpha="+string(alpha)
       +" degree")
```

Scilab code Exa 4.13 length of solution

```
1  clc
2  //to calculate length
3  l=40 //length in cm
4  c=5/100 //concentration in percentage
5  theta1 =35 //optical rotation in degree ,where theta1
       =theta'
6  c1 =10/100 //concentration in % ,where c1=c'
7  theta =20
8  //formula of specific rotation is alpha=10*theta/l*c
9  l1=l*c* theta1 /(c1* theta )
10 disp("length is l1="+string(l1)+"cm")
```

Scilab code Exa 4.14 rotation of plane of polarisation

```
1  clc
2  //to calculate rotation of plane of polarisation of
       light
3  mur =1.53914
4                  //refractive index
5  mul =1.53920
```

```
6  lambda =6.5*10^-5  //wavelength in cm
7  d=0.02  //distance in cm
8  thetaR =180*(mul-mur)*d/lambda
9  disp("rotation of plane of polarisation of light is
       thetaR="+string(thetaR)+"degree")
```

Scilab code Exa 4.15 percentage purity of sugar sample

```
1  clc
2  //to calculate % purity of the sugar sample
3  theta =9.9  //optical rotation in degree
4  alpha =66  //specific roation of pure sugar solution
       in dm^-1(gm/cc)^-1
5  l=20  //length of tube in cm
6  c=10*theta/(l*alpha)  //concentration of solution in
       gm/c.c
7  //it is given that 80 gm of impure sugar is
       dissolved in a litre of water
8  per=(c*100*10^3)/80  //here c is in gm/litre
9  disp("percentage of the sugar sample is per="+string
       (per)+"%")
```

Chapter 5

Lasers

Scilab code Exa 5.1 area of spot on the moon

```
1 clc
2 //to calculate area of the spot on the moon
3 lambda=6*10^-7 //wavelength in m
4 d=2 //diameter in m
5 dtheta=lambda/d //angular spread in radian
6 D=4*10^8 //distance of the moon
7 A=(D*dtheta)^2
8 disp("the areal spread is A="+string(A)+"m^2")
```

Scilab code Exa 5.2 angular spread and areal spread

```
1 clc
2 //to calculate angular spread of the beam
3 lambda=8*10^-7 //wavelength in m
4 d=5*10^-3 //aperture in m
5 dtheta=lambda/d
6 disp("the angular spread of the beam is dtheta="+
      string(dtheta)+"radian")
```

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```
7  //to calculate the areal spread when it reaches the
       moon
8  D=4*10^8 //distance of the moon in m
9  A=(D*dtheta)^2
10 disp("the areal spread is A="+string(A)+"m^2")
```

Scilab code Exa 5.3 number of oscillations and coherence time

```
1  clc
2  //to calculate number of oscillations corresponding
       to the coherence length
3  L=2.945*10^-2 //coherence length in m
4  lambda=5890*10^-10 //wavelength of sodium light in m
5  n=L/lambda
6  disp("the number of oscillations is n="+string(n)+"
       unitless")
7  //to calculate coherence time
8  c=3*10^8 //light speed in m
9  Time=L/c //coherence time
10 disp("the coherence Time="+string(Time)+"s")
```

Scilab code Exa 5.4 area and intensity of image

```
1  clc
2  //to calculate area and intensity of the image
3  lambda=7200*10^-10 //wavelength in m
4  d=5*10^-3 //aperture in m
5  dtheta=lambda/d //angular spread in radian
6  f=0.1 //focal length in m
7  arealspread=(dtheta*f)^2
8  disp("areal spread ="+string(arealspread)+"m^2")
9  power=50*10^-3
10 I=power/arealspread
```

```
11  disp(" intensity  of  the  image  is  I="+string(I)+" watts
       /m^2")
```

Chapter 6

Fiber optics and Holography

Scilab code Exa 6.1 critical angle and acceptance angle and numerical aperture and percentage of light collected

```
1  clc
2  // to  calculate  critical  angle  for  core−cladding
      interface
3  n1 =1.5
4  n2 =1.45
5  thetac = asind ( n2 / n1 )
6  theta1 =90 - thetac
7  disp ( " c r i t i c a l  angle  for  core−cladding  interface  is
      theta1= " + string ( theta1 ) + " degree " )
8  // to  calculate  acceptance  angle  in  air  for  fibre  and
        corresponding  angle  of  obliquences
9  na =1
10 thetaa = asind ( n1 * 0.26 / na )
11 disp ( " acceptance  angle  thetaa= " + string ( thetaa ) + "
      degree " )
12 // to  calculate  numerical  aperture
13 NA =(( n1 + n2 ) * ( n1 - n2 ) ) ^(1/2)
14 disp ( " numerical  aperture  of  fibre  is  NA= " + string ( NA )
      + " unitless " )
15 // to  calculate  %  of  light
```

```
16 per =( NA ) ^2*100
17 disp ("% of light collected is per="+string(per)+"%")
```

Scilab code Exa 6.2 numerical aperture and critical angle

```
1 clc
2 //to calculate numerical aperture
3 del =0.02 //relative refractive index difference
      between the core and the cladding of the fibre i.
      e. del=(n1−n2)/n1
4 n1 =1.46        //refractive index of core of W−step
      index fibre
5 n2=n1-del*n1
6 NA =((n1+n2)*(n1-n2))^(1/2)
7 disp ("numerical aperture is NA="+string(NA)+"
      unitless")
8 //to calculate critical angle at the core cladding
      interface within the fibre
9 thetac=asind(n2/n1)
10 disp ("thetac="+string(thetac)+"degree")
```

Scilab code Exa 6.3 refractive index and normalised frequency and total number of guided modes in the fibre

```
1 clc
2 //to calculate refractive index of the cladding
3 a=35*10^-6 //core diameter in micrometre
4 //formula is del=(n1−n2)/n1
5 //we get
6 del =1.5/100
7 n1 =1.46 //refractive index of the fibre
8 lambda=0.85*10^-6 //wavelength in micrometer
9 n2=n1-del*n1
```

```
10  disp("refractive index is n2="+string(n2)+"unitless"
       )
11  //to calculate normalised frequency V number of the
       fibre
12  V=(2*%pi*a*n1*0.173)/lambda
13  disp("normalised frequency V number of the fibre is
       V="+string(V)+"unitless")
14  //to calculate total number of guided modes in the
       fibre
15  M=(V^2)/2
16  disp("total number of guided modes in the fibre is M
       ="+string(M)+"modes")
```

Scilab code Exa 6.4 cutoff wavelength

```
1  clc
2  //to calculate cut−off wavelength of the fibre
3  //(2*del)^(1/2)=(2*(n1−n2)/n1)^(1/2)=(0.005)^(1/2)
       =0.071
4  a=5*10^-6 //radius in micrometre
5  n1=1.46 //core refractive index in micrometre
6  Vc=2.405 //cut−off value of V parametre for single
       mode operation
7  //formula is LAMBDAc=(2*%pi*a*n1*(2*del)^(1/2))/Vc
8  lambdac=(2*%pi*a*n1*0.071)/Vc
9  disp("cut−off wavelength is LAMBDAc="+string(lambdac
       )+"metre")
```

Scilab code Exa 6.5 maximum and minimum value of phase constant

```
1  clc
2  //to calculate maximum and minimum value of phase
       constant
```

```
 3  lambda=0.8*10^-6 //wavelength in micrometre
 4  n1=1.6*10^-6
 5                        //refractive indices in
                              micrometre
 6  n2=1.44*10^-6
 7  maximum=(2*%pi*n1)/lambda
 8  minimum=(2*%pi*n2)/lambda
 9  disp("maximum value of phase constant is maximum="+
        string(maximum)+"radian/micrometre")
10  disp("minimum value of phase constant is minimum="+
        string(minimum)+"radian/micrametre")
```

Chapter 7

Wave Mechanics

Scilab code Exa 7.1 de broglie wavelength

```
1  clc
2  //to calculate de Broglie wavelength
3  v=1.5*10^7 //velocity of proton =(1/20)*velocity of
       light i.e.3*10^8 in m/s
4  m=1.67*10^-27 //mass of the proton in kg
5  h=6.6*10^-34 //plank's constant
6  lambda=h/(m*v)
7  disp("the de Broglie wavelength is lambda="+string(
       lambda)+"m")
```

Scilab code Exa 7.2 de broglie wavelength

```
1  clc
2  //to calculate de Broglie wavelength
3  //mo*c^2=1.507*10^-10/1.6*10^-19=941.87 Mev
4  //since 12.8 Mev is very small compared to rest mass
       energy hence relavistic consideration may be
       ignored
```

```
5  m=1.67*10^-27 //mass in kg
6  h=6.62*10^-34 //plank's constant
7  E=12.8*10^6 //energy in Mev
8  lambda=h/sqrt(2*m*E*1.6*10^-19)
9  disp("thede Broglie wavelength is lambda="+string(
      lambda)+"angstrom")
```

Scilab code Exa 7.4 wavelength

```
1  clc
2  //to calculate wavelength
3  h=6.6*10^-34 //plank's constant
4  m=9.1*10^-31 //mass of electron in kg
5  E=1.25*10^3 //pottential difference keV
6  lambda=h/sqrt(2*m*E*1.6*10^-19)
7  disp("the wavelength is lambda="+string(lambda)+"
      angstrom")
```

Scilab code Exa 7.5 Kinetic energy of electron

```
1  clc
2  //to calculate kinetic energy of an electron
3  h=6.63*10^-34 //plank's constant
4  mo=9.1*10^-31 //rest mass of an electron in kg
5  lambda=5896*10^-10  //wavelength in angstrom
6  K=(h^2)/(2*mo*(lambda^2)*1.6*10^-19)
7  disp("kinetic energy of an electron is K="+string(K)
      +"eV")
```

Scilab code Exa 7.6 wavelength of electron

```
1  clc
2  //to calculate the wavelength of an electron of
      kinetic energy
3  mo=9.1*10^-31 //mass of an electron in kg
4  c=3*10^8 //speed of light in m/s
5  K=1*10^6//kinetic energy in eV
6  h=6.62*10^-34 //planck's constant in J−s
7  //E=moc^2=81.9*10^−15/1.6*10^−19 eV=0.51MeV
8  E=0.51*10^6
9  lambda=(h*c)/(sqrt(K*(K+2*E))*1.6*10^-19)
10 disp("wavelength of an electron of kinetic energy is
       lambda="+string(lambda)+"m")
```

Scilab code Exa 7.7 de broglie wavelength of electron

```
1  clc
2  //to calculate de Broglie wavelength
3  V=100 //potential difference in volts
4  lambda=12.25/sqrt(V)
5  disp("de Broglie wavelength of any electron is
      lambda="+string(lambda)+"angstrom")
```

Scilab code Exa 7.9 energy of neutron

```
1  clc
2  //to calculate energy of the neutron
3  h=6.60*10^-34 //plank's constant in J/s
4  m=1.674*10^-27 //mass of the neutron in kg
5  lambda=10^-10 //de Broglie wavelength in m
6  E=(h^2)/(2*m*(lambda^2)*1.6*10^-19)
7  disp("energy of the neutron is E="+string(E)+"eV")
```

Scilab code Exa 7.10 wavelength and number of photons

```
1  clc
2  //to calculate wavelength
3  h=6.6*10^-34 //plank's constant in J/sec
4  m=9.1*10^-31 //mass of electron in kg
5  c=3*10^8 //light speed in m/s
6  lambda=h/(m*c)
7  disp("wavelength of quantum of radiant energy is
        lambda="+string(lambda)+"m")
8  //to calculate number of photons
9  power=12 //power emitted by the lamp =150*(8/100) in
        watts
10 E=12 //energy emitted per second
11 lambda=4500*10^-10
12 energy=(h*c)/lambda //energy contained in one photon
        in J
13 number=E/energy
14 disp("number of photons emitted per sec is number="+
        string(number)+"unitless")
```

Scilab code Exa 7.11 uncertainity in position of electron

```
1  clc
2  //to calculate uncertainity in position
3  //actual formula is (delx)min*(delp)max=h/2*%pi
        ————————————eq(1)
4  //(delp)max=p(momentum of the electron)
5  //mv=mov/sqrt(1-(v/c)^2)————————————————eq(2)
6  mo=9*10^-31 //mass of an electron in m/s
7  c=3*10^8 //light speed in m/s
8  v=3*10^7 //velocity in m/s
```

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```
9  h=6.6*10^-34 //plank's constant in J/s
10 //from eq(1) and eq(2),we get
11 delxmin=(h*sqrt(1-(v/c)^2))/(2*%pi*mo*v)
12 disp("smallest possible uncertainity in the position
        of an electron is delxmin="+string(delxmin)+"m")
```

Scilab code Exa 7.12 uncertainity in velocity

```
1  clc
2  //to calculate minimum uncertainity in the velocity
3  delxmax=10^-8 //maximum uncertainity in position in
      m
4  h=6.626*10^-34 //planck's constant
5  delpmin=h/(2*%pi*delxmax) //minimum uncertainity in
      momentum in kg-m/s^2
6  m=9*10^-31 //mass of an electron in kg
7  delvmin=delpmin/m
8  disp("minimum uncertainity in the velocity is
      delvmin="+string(delvmin)+"m/s")
```

Scilab code Exa 7.13 uncertainity in momentum and velocity of electron
and alpha particle

```
1  clc
2  //to calculate uncertainity in the momentum of the
      parcticle
3  h=6.626*10^-34 //planck's constant J-s
4  delx=0.01*10^-2 //uncertainity in position in m
5  delp=h/(2*%pi*delx)
6  disp("uncertainity in the momentum of the parcticle
      is delp="+string(delp)+"kg-m/s^2")
7  //to calculate uncertainity in the velocity of an
      electron
```

```
8  m=9*10^-31 //mass of an electron in kg
9  delx=5*10^-10
10 delv=h/(2*%pi*m*delx)
11 disp(" uncertainity in the velocity of an electron is
       delv="+string(delv)+"m/s")
12 //to calculate uncertainity in the velocity of alpha
       particle
13 m=4*1.67*10^-27 //mass of alpha particle in kg
14 delx=5*10^-10
15 delv=h/(2*%pi*m*delx)
16 disp(" uncertainity in the velocity of an electron is
       delv="+string(delv)+"m/s")
```

Scilab code Exa 7.14 uncertainity in position of electron

```
1 clc
2 //to calculate uncertainity in position
3 m=9.11*10^-31 //mass of electron in kg
4 delv=40 //uncertainity in velocity in m/s
5 h=6.6*10^-34 //plank's constant
6 delx=h/(2*%pi*m*delv)
7 disp(" uncertainity in the position of the electron
       is delx="+string(delx)+"m")
```

Scilab code Exa 7.15 uncertainity in frequency

```
1 clc
2 //to calculate uncertainity in frequency
3 //delE*delt=h/2*%pi————eq(1)
4 //delE=h*delv————————eq(2)
5 delt=10^-8 //uncertainity in time in s
6 //from eq(1) and eq(2),we get
7 delnu=1/(2*%pi*delt)
```

```
8 disp("minimum uncertainity in the frequency of the
      photon is delv="+string(delnu)+"sec^-1")
```

Scilab code Exa 7.16 minimum error

```
1 clc
2 //to calculate uncertainity in the energy
3 h=6.63*10^-34 //plank's constant in J-s
4 delt=2.5*10^-14 //uncertainity in time in s
5 delE=h/(2*%pi*delt*1.6*10^-19)
6 disp("minimum error with which the energy of the
      state can be measured is delE="+string(delE)+"ev"
      )
```

Scilab code Exa 7.17 time required for the atomic system

```
1 clc
2 //to calculate time required for the atomic system
3 //delE=h*c*dellambda/lambda^2 -----eq(1)
4 //delE*delt=h/2*%pi----------eq(2)
5 dellambda=10^-14
6 c=3*10^8
7 lambda=6*10^-7
8 //from eq(1)and eq(2),we get
9 delt=(lambda^2)/(2*%pi*c*dellambda)
10 disp("time required for the atomic system to retain
      rotational energy is delt="+string(delt)+"s")
```

Scilab code Exa 7.18 uncertainity in momentum and kinetic energy of the nucleon

```
1  clc
2  // to calculate minimum uncertainity in the momentum
3  delxmax=5*10^-14 // uncertainity in position in m
4  h=6.626*10^-34 // plank's constant in Js
5  delpmin=h/(2*%pi*delxmax)
6  disp("minimum uncertainity in the momentum of the
       nucleon is delpmin="+string(delpmin)+"kg m/s")
7  m=1.675*10^-27 // mass in kg
8  Emin=(delpmin^2)/(2*m*1.6*10^-19)
9  disp("minimum kinetic energy of the nucleon is Emin=
       "+string(Emin)+"eV")
10 // the answer is given wrong in the book Emin=0.039
       eV
```

Scilab code Exa 7.19 uncertainity in velocity

```
1  clc
2  // to calculate uncertainity in velocity
3  delx=1.1*10^-8 // uncertainity in velocity in m
4  h=6.626*10^-34 // plank's constant
5  m=9.1*10^-31 // mass of electron in kg
6  delv=h/(2*%pi*m*delx)
7  disp("minimum uncertainity in velocity is delv="+
       string(delv)+"m/s")
```

Scilab code Exa 7.20 uncertainity in frequency and energy of electron

```
1  clc
2  // to calculate uncertainity in frequency
3  delt=10^-8 // uncertainity in time
4  delnu=1/(2*%pi*delt)
5  disp("minimum uncertainity in the frequency of a
       photon is delnu="+string(delnu)+"sec^-1")
```

```
6  //to use the uncertainity principle to place a lower
       limit on the energy an electron must have if it
     is to be part of a nucleus
7  delx=5*10^-15 //uncertainity in position
8  delp=h/(2*2*%pi*delx) //uncertainbity in momentum
9  c=3*10^8 ///speed of light in m/s
10 E=delp*c
11 disp("energy of an electron is E="+string(E)+"J")
```

Scilab code Exa 7.22 probability of finding the particle

```
1  clc
2  //to calculate probability of finding the particle
3  a=25*10^-10//width in angstrom
4  //wave function of the particle is chi(x)=sqrt(2/a)*
     sin(n*%pi*x/a),for the particle in the least
     energy state n=1
5  chix=sqrt(2/a)*sin(%pi*(a/2)/a)
6  delx=5*10^-10 //interval in angstrom
7  P=delx*chix^2
8  disp("probability of finding the particle is P="+
     string(P)+"unitless")
```

Scilab code Exa 7.24 energy of electron

```
1  clc
2  //to calculate energy of an electron
3  n=1 //least energy of the particle
4  h=6.63*10^-34 //planck's constant in Js
5  m=9.11*10^-31 //mass of electron in kg
6  a=10^-10 //width in angstrom
7  E=(n^2)*(h^2)/(8*m*(1.602*10^-19)*a^2)
```

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```
8  disp("energy of an electron moving in one dimension
      in an infinitely high potential box is E="+string
      (E)+"eV")
9  //the answer is given wrong in the book E=5.68 eV
```

Scilab code Exa 7.26 probability of particle

```
1  clc
2  //to calculate probability
3  x1=0.45  //x1=0.45*L
4  x2=0.55         //x2=0.55*L
5  n=1                     //for ground state
6  //formula is P=integrate('(2/L)*sin(n*%pi*x)^2)','x',
      x1,x2)
7  P1=integrate('2*(sin(n*%pi*x)^2)','x',x1,x2)
8  disp("P1="+string(P1)+"unitless")
9  probability1=P1*100
10 disp("probability for the ground states is
      probability1 ="+string(probability1)+"%")
11 n=2              //for first excited state
12 P2=integrate('2*(sin(n*%pi*x)^2)','x',x1,x2)
13 disp("P2="+string(P2)+"unitless")
14 probability2=P2*100
15 disp("probability for first excited states is
      probability2="+string(probability2)+"%")
```

Scilab code Exa 7.28 energy of neutron

```
1  clc
2  //to calculate energy of a neutron
3  //consider nucleus as a cubical box of size 10^-14m
4  //x=y=z=a=10^-14=l
```

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```
5  //for  neutron  to  be  in  the  lowest  energy  state  nx=ny
       =nz=1
6  //formula  is  E=(%pi^2*h^2/8*%pi^2*m)*((nx/lx)^2+(ny/
       ly)^2+(nz/lz)^2)
7  h=6.626*10^-34   //planck's  constant  in  Js
8  m=1.6*10^-27  //mass  in  kg
9  l=10^-14  //in  m
10 E=(%pi^2)*(h^2)*3/(4*(%pi^2)*2*m*(1.6*10^-19)*l^2)
11 disp("lowest  energy  of  a  neutron  is  E="+string(E)+"
       eV")
```

Scilab code Exa 7.29 zero point energy

```
1  clc
2  //to  calculate  zero  point  energy  of  a  linear
       harmonic  oscillator
3  h=6.63*10^-34  //planck's  constant  in  Js
4  nu=50  //frequency  in  Hz
5  zeropointenergy=(h*nu)/2
6  disp("zeropointenergy="+string(zeropointenergy)+"J")
```

Scilab code Exa 7.30 zero point energy

```
1  clc
2  //to  calculate  zero  point  energy
3  nu=1  //frequency  in  Hz
4  h=6.63*10^-34  //planck's  constant  in  Js
5  zeropointenergy=(h*nu)/2
6  disp("zeropointenergy="+string(zeropointenergy)+"J")
```

Scilab code Exa 7.31 frequency of vibration

```
1  clc
2  //to calculate frequency of vibration
3  En=0.1*1.6*10^-19 //energy of a linear harmonic
       oscillator in eV
4  n=3 //third excited state
5  h=6.63*10^-34 //planck's constant
6  nu=En/((n+(1/2))*h)
7  disp("the frequency of vibration is nu="+string(nu)+
       "Hz")
```

Chapter 8

X Rays

Scilab code Exa 8.1 value of plancks constant

```
1 clc
2 //to calculate value of planck's constant
3 e=1.6*10^-19 //in C
4 V=100*10^3 //voltage in KV
5 c=3*10^8 //light speed in m/s
6 lambdamin=12.35*10^-12 //wavelength in m
7 h=e*V*lambdamin/c
8 disp("the value of plancks constant is h="+string(h)
      +"J-s")
```

Scilab code Exa 8.2 maximum frequency

```
1 clc
2 //to calculate maximum frequency
3 h=6.6*10^-34 //planck's constant in J-s
4 c=3*10^8 //light speed in m/s
5 Ve=50000 //accelerating potential in V
6 lambdamin=h*c/Ve //wavelength in m
```

```
7  numax=c/lambdamin
8  disp("maximum frequency present in the radiation
       from an X-ray tube is numax="+string(numax)+"Hz")
9  //answer is given in thec book is incorrect
       =1.2*10^19 Hz
```

Scilab code Exa 8.3 number of electrons and speed

```
1   clc
2   //to calculate number of electrons
3   I=2*10^-3 //current in mA
4   e=1.6*10^-19
5   n=I/e
6   disp("number of electrons striking the target per
        second is n="+string(n)+"unitless")
7   //to calculate speed
8   m=9.1*10^-31 //mass of electron in kg
9   V=12.4*10^3 //potential difference in V
10  v=sqrt(2*V*e/m)
11  disp("the speed with which electrons strike the
        target is v="+string(v)+"m/s")
```

Scilab code Exa 8.4 longest wavelength

```
1  clc
2  //to calculate wavelength
3  n=2 //second order for longest wavelength
4  d=2.82*10^-10 // spacing in angstrom
5  sintheta=1
6  lambdamax=2*d*sintheta/n
7  disp("the longest wavelength that can be analysed by
        a rock salt crystal is lambdamax="+string(
     lambdamax)+"m")
```

Scilab code Exa 8.5 spacing of crystal

```
1  clc
2  //to calculate spacing of the crystal
3  h=6.62*10^-34 //planck's constant in J-s
4  m=9.1*10^-31 //mass of electron in kg
5  V=344 //voltage in V
6  e=1.6*10^-19
7  lambda=h/sqrt(2*m*e*V) //wavelength in m
8  //according to Bragg's law
9  n=1
10 //formula is 2*d*sintheta=n*lambda
11 d=n*lambda/(2*sin(%pi/6))
12 disp("the spacing of the crystal is d="+string(d)+"m
      ")
```

Scilab code Exa 8.6 wavelength

```
1  clc
2  //to calculate wavelength of Kalpha line for an atom
3  R=1.1*10^5
4  z=92
5  //Ka line is emitted when electron jumps from l
      shell(n2=2) to k shell(n1=1)
6  //formula is 1/alphaa=R*(z-b)*((1/n1^2)-(1/n2)^2)
7  alphaa=4/(3*R*(z-1)^2)
8  disp("wavelength of Kalpha line for an atom is
      alphaa="+string(alphaa)+"cm")
```

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Scilab code Exa 8.7 thickness

```
1  clc
2  //to calculate thickness
3  //mass absorption coefficient mum of an absorber is
       related with linear absorption coefficient mu and
        density of the material rho is given by
4  //mu=rho*mum=2.7*0.6=1.62 cm^-1
5  mu=1.62
6  //if initial intensity Io of the X-ray beam is
       reduced to I in traversing a distance x in
       absorber I=Io*e^-mu*x
7  //where I/Io=20
8  //put above values in the below equation , we get
9  x=(2.3026*(log(20)/log(10)))/1.62
10 disp("thickness is x="+string(x)+"cm")
```

Scilab code Exa 8.8 atomic number

```
1  clc
2  //to calculate atomic number of the element
3  //equation for balmer series in hydrogen spectrum is
       1/lambda=R*((1/2^2)-(1/n^2))
4  //for series limit n=infinity ,R=4/lambdainfinity i.
       e. R=4/364.6nm
5  //X-ray wavelength of K series is 1/lambda=R*(z-1)
       ^2*((1/1^2)-(1/n^2))
6  lambda=0.1*10^-9
7  R=4/(364.6*10^-9)
8  //for n=infinity ,minimum wavelength of k series is
       given by
9  z=sqrt(1/(lambda*R))+1
10 disp("atomic number is z="+string(z)+"unitless")
```

Scilab code Exa 8.9 wavelength of X Rays

```
1 clc
2 //to calculate wavelength
3 d=1.87*10^-10 //spacing in angstrom
4 n=2
5 //formula is lambda=2*d*sintheta/n
6 lambda=2*d*sin(%pi/6)/n
7 disp("the waelength of X-rays is lambda="+string(
      lambda)+"m")
```

Scilab code Exa 8.10 wavelength of second X Ray beam

```
1 clc
2 //to calculate wavelength of second X-ray beam
3 //from bragg's law
4 //lambda=(d*sin(%pi/3))/n              eq(1)
5 //it is given that,theta=60,n=3,lambda=1.97 angstrom
6 //from eq(1) we get,2*d*sin60degree=3*0.97
                      eq(2)
7 //let lambda' be the second X-ray beam
8 //we get 2*d'*sin theta'=n'*lambda'
                        eq(3)
9 //from eq(2) and eq(3),we get
10 lambda1=sin(%pi/6)*3*0.97/sin(%pi/3)    //where
      lambda1=lambda'
11 disp("wavelength of X-ray is lambda1="+string(
      lambda1)+"angstrom")
```

Scilab code Exa 8.11 wavelength of X Ray used

```
1  clc
2  //to calculate wavelength
3  d=2.82*10^-10 //spacing in m
4  n=1
5  lambda=2*d*sin(10*%pi/180)/n
6  disp("wavelength of X-ray is lambda="+string(lambda)
       +"m")
```

Scilab code Exa 8.12 possible spacing of the set of planes

```
1  clc
2  //deduce possible spacing of the set of planes
3  //for first order , 2*d*sintheta1=1*lambda...eq(1)
4  //for second order ,2*d*sintheta2=2*lambda..eq(2)
5  //for third order , 2*d*sintheta3=3*lambda......eq(3)
6  //for fourth order , 2*d*sintheta4=4*lambda
       ............eq(4)
7  //divide eq(2) by eq(1),we get sintheta2=2*sintheta1
8  //similarly ,sintheta3=3*sintheta1 ,sintheta4=4*
       sintheta1
9  lambda=1.32*10^-10
10 sintheta1=0.1650
11 d1=lambda/(2*sintheta1)//for first order n=1,d1=d/n
12 d2=lambda/(2*2*sintheta1)    //for second order n=2,
       d2=d/n
13 d3=lambda/(2*3*sintheta1)        //for third order n
       =3,d3=d/n
14 d4=lambda/(2*4*sintheta1)          //for fourth
       order n=4,d4=d/n
15 disp("d1="+string(d1)+"m")
16 disp("d2="+string(d2)+"m")
17 disp("d3="+string(d3)+"m")
18 disp("d4="+string(d4)+"m")
```

Scilab code Exa 8.13 Compton shift and wavelength and fraction of energy lost

```
1  clc
2  //to calculate compton shift and wavelength
3  h=6.63*10^-34 //planck's constant in J-s
4  m0=9.11*10^-31 //mass of electron
5  c=3*10^8 //light speed in m/s
6  dellambda=h*(1-(1/sqrt(2)))/(m0*c)
7  lambda0=2*10^-10
8  lambda=dellambda+lambda0
9  disp("compton shift is dellambda="+string(dellambda)
       +"m")
10 disp("wavelength of the scattered X-rays is lambda="
       +string(lambda)+"m")
11 //to calculate fraction of energy lost by the photon
        in the collision
12 //energy lost =E0-E/E0=(hc/lambda0)-(hc/lambda)/(ha/
       lambda0)
13 //we get,
14 energylost=dellambda/lambda
15 disp("energylost ="+string(energylost)+"unitless")
```

Scilab code Exa 8.14 wavelength and energy of photon

```
1  clc
2  //to calculate wavelength and energy
3  //formula is lambda'-lambda=h*(1-cos phi)/(m0*c),
       where phi=90 degree, lambda'=2lambda
           ----------------eq(1)
4  //dellambda=2lambda-lambda=lambda
           --------------------------eq(2)
```

```
5  h=6.62*10^-34 //planck's constant
6  c=3*10^8 //light speed in m.s
7  m0=9*10^-31 //mass of electron in kg
8  //from eq(1) and eq(2) ,we get
9  lambda=h/(m0*c)
10 disp("wavelength is lambda="+string(lambda)+"m")
11 E=h*c/lambda
12 disp("energy of the incident photon is E="+string(E)
      +"J")
```

Scilab code Exa 8.15 wavelength and direction of electron

```
1  clc
2  //to calculate wavelength of radiation and direction
      of emission
3  h=6.6*10^-34            //planck's constant in J-s
4  c=3*10^8                //speed of light in m/s
5  energy=510*10^3                //energy of photon in
      eV
6  lambda=h*c/(energy*1.6*10^-19)
7  mo=9.1*10^-31                //mass of electron in Kg
8  lambda1=lambda+h*(1-cos(%pi/2))/(mo*c)
9  disp("wavelength of radiation is lambda1="+string(
      lambda1)+"m")
10 theta=atand(lambda*sin(%pi/2)/(lambda1-lambda*cos(
      %pi/2)))
11 disp("direction of emission of electron is theta="+
      string(theta)+"degree")
```

Scilab code Exa 8.16 wavelength of two X Rays and maximum wavelength present in the scattered X Rays and maximum kinetic energy

```
1  clc
```

```scilab
2  //to calculate wavelength of two X-rays
3  h=6.6*10^-34 //planck's constant in J-s
4  c=3*10^8 //light speed in m/s
5  mo=9.1*10^-31 //mass of electron in kg
6  lambda=10*10^-12 //wavelength in pm
7  lambda1=lambda+((h/(mo*c))*(1-(1/sqrt(2))))
8  disp("wavelength of two X-rays is lambda1="+string(
      lambda1)+"m")
9  //to calculate maximum wavelength
10 lambda2=lambda+((2*h)/(mo*c))
11 disp("maximum wavelength present in the scattered X-
      rays is lambda2="+string(lambda2)+"m")
12 //to calculate maximum kinetic energy
13 Kmax=(h*c)*((1/lambda)-(1/lambda2))/(1.6*10^-19)
14 disp("maximum kinetic energy of the recoil electrons
       is Kmax="+string(Kmax)+"eV")
```

Chapter 9

Dielectric Properties of Materials

Scilab code Exa 9.1 dielectric constant of liquid

```
1  clc
2  //to calculate dielectric constant of the liquid
3  //capacitance of the air filled dielectric Cair=Q/Vo
        ————————eq(1)
4  //when dielectric is filled between the plates ,
      Cliquid=Q/V
5  //then Cliquid=epsilonr*Q/Vo————————eq(2)
6  Vo=60
7                    //voltage in volts
8  V=30
9  //from eq(1) and eq(2),we get
10 epsilon0=Vo/V
11 disp("the dielectric constant of the liquid is
      epsilon0="+string(epsilon0)+"unitless")
```

Scilab code Exa 9.2 charge on capacitor

```
1  clc
2  //to calculate charge on the capacitance
3  epsilon0=8.854*10^-12 //permittivity
4  epsilonr=6 //relative permittivity
5  V=100 //voltage in volts
6  d=1.5*10^-3 //distance in m
7  A=4*10^-4//area in m^2
8  Q=epsilon0*epsilonr*A*V/d
9  disp("the charge on the capacitance is Q="+string(Q)
      +"Coulomb")
```

Scilab code Exa 9.3 resultant voltage

```
1  clc
2  //to calculate voltage
3  A=6.50*10^-4 //area in m^2
4  Q=2*10^-10 //charge in C
5  d=4*10^-3 //plate separation in m
6  epsilon0=8.854*10^-12
7  epsilonr=3.5 //dielectric constant
8  V=Q*d/(epsilon0*epsilonr*A)
9  disp("the resultant voltage across the capacitor is
      V="+string(V)+"volt")
```

Chapter 10

Magnetic Properties of Materials

Scilab code Exa 10.1 permeability and susceptibility of bar

```
1  clc
2  //to calculate permeability and susceptibility of
       the bar
3  phi=2.4*10^-5 //magnetic flux in weber
4  A=0.2*10^-4 //cross sectional area in m^2
5  B=phi/A //magnetic induction in N/Am
6  H=1200 //magnetising field in A/m
7  mu=B/H
8  disp("permeability is mu="+string(mu)+"N/A^2")
9  muo=4*%pi*10^-7
10 chim=(mu/muo)-1
11 disp("susceptibility is chim="+string(chim)+"
       unitless")
12 //the answer is given wrong in the book (round off
       error) chim=737
```

Scilab code Exa 10.2 current

```
1  clc
2  //to calculate current should be sent through the
       solenoid
3  l=.10 //length in m
4  N=50 //number of turns
5  H=5*10^3 //magnetising field in A/m
6  i=H*l/N
7  disp("current is i="+string(i)+"A")
```

Scilab code Exa 10.3 magnetic moment of rod

```
1  clc
2  //to calculate magnetic moment of the rod
3  //formula is B=muo*(H+I)
4  //where H=ni
5  n=500 //number of turns in turns/m
6  i=0.5 //current passed through the solenoid in A
7  mur=1200 //relative permeability
8  I=(mur-1)*n*i //intensity of magnetisation in A/m
9  V=10^-3 //volume in m^3
10 M=I*V
11 disp("the magnetic moment of the rod is M="+string(M
       )+"A-m^2")
```

Scilab code Exa 10.4 flux density and magnetic intensity and permeability

```
1  clc
2  //to calculate flux density ,magnetic intensity ,
       permeability of iron
3  phi=2*10^-6 //flux in the ring in weber
```

```
4  A=10^-4 //cross-sectional area in m^2
5  B=phi/A
6  disp("flux density is B="+string(B)+"weber/m^2")
7  N=200 //number of turns
8  i=0.30 //current flows in the windings in A
9  l=0.2 //length in m
10 H=N*i/l
11 disp("magnetic intensity is H="+string(H)+"A-turn/m"
      )
12 mu=B/H
13 disp("permeability is mu="+string(mu)+"weber/A-m")
14 muo=4*%pi*10^-7
15 mur=mu/muo
16 disp("relative permeability is mur="+string(mur)+"
      unitless")
```

Scilab code Exa 10.5 number of ampere turns

```
1  clc
2  //to calculate number of ampere turns
3  l=0.5 //length in m
4  mu=6.5*10^-3 //permeability of iron in henry/m
5  A=2*10^-4 //area of cross-section in m^-4
6  R=l/(mu*A) //reluctance in A-turns/weber
7  flux=4*10^-4 //in weber
8  mmf=flux*R
9  disp("the number of ampere turns is mmf="+string(mmf
      )+"ampere-turns")
```

Scilab code Exa 10.6 relative permeability

```
1  clc
2  //to calculate relative permeability of the medium
```

```
3  phi =1.5*10^-3 //magnetic flux in weber
4  l=%pi*50*10^-2 //length in m
5  A=10*10^-4 //area of cross-section
6  N=1000 //number of turns
7  i=5 //current in A
8  muo =4*%pi*10^-7
9  //phi(magnetic flux)=m.m.f/reluctance
10 //phi=N*i*muo*mur*A/l
11 //we get,
12 mur=phi*l/(N*i*A*muo)
13 disp("relative permeability of the medium is mur="+
        string(mur)+"unitless")
```
_____

Scilab code Exa 10.7 magnetising current

```
1  clc
2  //to calculate magnetising current
3  //formula is phi(magnetic flux)=m.m.f/reluctance
4  //phi=N*i*mu*A/l————————eq(1)
5  //phi=BA——————————eq(2)
6  B=0.20 //magnetic flux density in weber/m^2
7  l=1 //average length of the circuit in m
8  N=100 //number of turns
9  mu=7.3*10^-3 //in h.m
10 //from eq(1)and eq(2),we get
11 i=B*l/(N*mu)
12 disp("magnetising current is i="+string(i)+"A")
```
_____

Chapter 11

Ultrasonics

Scilab code Exa 11.1 fundamental frequency

```
1  clc
2  //to calculate fundemental frequency
3  Y=7.9*10^10 //Young modulus for quartz in Nm^-2
4  rho=2.65*10^3 //density of quartz in kg/m^3
5  //the velocity of longitudinal wave is given by
6  v=sqrt(Y/rho)  //in m/s
7  //for fundamental mode of vibration ,thickness is
       given by lambda/2
8  lambda=2*0.001 //wavelength in m
9  nu=v/lambda
10 disp("the fundamental frequency is nu="+string(nu)+"
      Hz")
11 //answer is given wrong in the book ,nu=2730 Hz
```

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Chapter 12

Electromagnetics

Scilab code Exa 12.1 electric flux and flux

```
1  clc
2  //to calculate electric flux
3  //electric flux through a surface is phi=vector(E)*
       vector(s)
4  //where vector E=2i+4j+7k, vector s=10j
5  E=4                    //E=4j
6  s=10                   //s=10j
7  phi=E*s
8  disp("electric flux is phi="+string(phi)+"units")
9  //to calculate flux coming out of any face of the
       cube
10 q=1              //charge in coulomb
11 epsilon0=8.85*10^-12              //permittivity in
       free space in coul^2/N-m^2
12 phi1=q/(6*epsilon0)
13 disp("flux coming out of any face of the cube is
       phi1="+string(phi1)+"N-m^2/coul^2")
```

Scilab code Exa 12.2 electric field

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```
1  clc
2  //to calculate electric field at a point from centre
       of the shell
3  q=0.2*10^-6 //charge
4  r=3 //radius
5  epsilon0 =8.85*10^-12
6  E=q/(4*%pi*epsilon0*r^2)
7  disp(" electric field at a point from centre of the
       shell is E="+string(E)+"N/coulomb")
8  //to calculate electric field at a point just
       outside the shell
9  R=0.25 //radius
10 E=q/(4*%pi*epsilon0*R^2)
11 disp(" electric field at a point just outside the
       shell is E="+string(E)+"N/coulomb")
12 //to calculate the electric field at a point inside
       the shell
13 //when the point is situated inside the spherical
       shell ,the electric field is zero
```

Scilab code Exa 12.3 electric field

```
1  clc
2  //to calculate electric field at a point on earth
       vertically below the wire
3  lambda=10^-4 //wavelength in coulomb/m
4  r=4 //radius in m
5  epsilon0 =8.854*10^-12
6  E=2*lambda/(4*%pi*epsilon0*r)
7  disp(" electric field at a point on earth vertically
       below the wire is E="+string(E)+"N/coulomb")
```

Scilab code Exa 12.4 separation between the equipotential surfaces

```
1  clc
2  //to calculate separation between those
       equipotential surfaces
3  V=5 //potential difference
4  epsilon0=8.85*10^-12 //permittivity of free space
5  sigma=1*10^-7   //in c/m^2
6  //electric field due to an infinite sheet of surface
       charge density is given by E=sigma/(2*epsilon0)
                       eq(1)
7  //E=V/d                          eq(2)
8  //from eq(1) and eq(2),we get
9  d=(2*epsilon0*V)/sigma
10 disp("separation between those equipotential
       surfaces is d="+string(d)+"m")
```

Scilab code Exa 12.5 force per unit area

```
1  clc
2  //to calculate force per unit area
3  //force of attraction per unit area is given by F=(
       epsilon0*E^2)/2                 eq(1)
4  //E=V/d                             eq(2)
5  epsilon0=8.85*10^-12 //permittivity  of free space
6  d=1*10^-3 //distance
7  V=100 //potential difference in volts
8  //from eq(1) and eq(2),we get
9  F=(epsilon0*V^2)/(2*d^2)
10 disp("force per unit area is F="+string(F)+"N/m^2")
11 //answer is given incorrect in the book ,F
       =4.425*10^-12
```

Scilab code Exa 12.6 charge

```
1  clc
2  //to calculate charge
3  //let charge be q coulomb ,then the surface density
       of charge i.e. sigma=q/(4*%pi*r^2)..............
       eq(1)
4  //outward pull per unit area =sigma^2/(2*epsilon0)
       ............eq(2)
5  //put eq(1) in eq(2),we get q^2/(4*%pi*r^2)^2*(2*
       epsilon0)..............eq(3)
6  //pressure due to surface tension =4*T/r............
       eq(4)
7  T=27
8  r=1.5*10^-2
9  epsilon0=8.85*10^-12
10 //equate eq(3) and eq(4),we get
11 q=sqrt(4*T*((4*%pi*r^2)^2)*2*epsilon0/r)
12 disp("charge is q="+string(q)+"coulomb")
13 //answer is given wrong in the book,square of 4*%pi*
       r^2 is not taken in the solution.
```

Scilab code Exa 12.7 increase in radius

```
1  clc
2  //to calculate increase in radius
3  q=4.8*10^-8          //charge in coulomb
4  r=10*10^-2 //radius in m
5  epsilon0=8.85*10^-12   //C^2/N–m^2
6  P=10^5 //N/m^2
7  dr=(q^2)/(96*((%pi)^2)*(r^3)*epsilon0*P)
8  disp("increase in radius is dr="+string(dr)+"m")
```

Scilab code Exa 12.8 average values of intensities

```
1  //in  page  no.340 ,numbering  is  done  wrongly , it  should
        be  like  ex −8,ex −9,ex −10,ex −11,ex −12,ex −13,ex −14
2  clc
3  //to  calculate  average  values  of  intensities  of
        electric  and  magnetic  fields  of  radiation
4  //energy  of  lamp=1000  J/s
5  //area  illuminated  =4*%pi*r^2=16*%pi  m^2
6  //energy  radiated  per  unit  area  per  second  =1000/16*
        %pi
7  //from  poynting  theorem  |s|=|E*H|=E*H                eq
        (1)
8  s=1000/(16*%pi)
9  muo=4*%pi*10^-7                    //permeability  of  free
        space
10 epsilon0=8.85*10^-12                      //permittivity  in
        free  space
11 //E/H=sqrt(muo/epsilon0)            eq(2)
12 //from  eq(1)  and  eq(2) ,we  get
13 E=sqrt(s*sqrt(muo/epsilon0))
14 H=s/E
15 disp(" average  value  of  intensity  of  electric  fields
        of  radiation  is  E="+string(E)+"V/m")
16 disp(" average  value  of  intensity  of  magnetic  fields
        of  radiation  is  H="+string(H)+" ampere−turn /m")
17 //answer  is  given  wrong  in  the  book  E=48.87  V/m,
        solution  of  magnetic  fields  is  not  given  in  the
        book  .
```

Scilab code Exa 12.9 amplitudes of electric and magnetic fields

```
1  clc
2  //to  calculate  amplitudes  of  electric  and  magnetic
        fields  of  radiation
3  //energy  received  by  an  electromagnetic  wave  per  sec
        per  unit  area  is  given  by      poynting  vector  |s
```

```
     |=|E*H|=E*H*sin 90 ( becoz E is perpendicular to H
         )
4  // it is given that energy received by earth's
        surface is
5  s=1400                    // | s |=2 cal min^-1 cm^-2
6  muo =4*%pi*10^-7 // permittivity of free space
7  epsilon0 =8.85*10^-12 // permeability of free space
8  //E*H=1400                             eq (1)
9  //E/H=sqrt(muo/epsilon0)                eq (2)
10 // from eq (1) and eq (2) , we get
11 E=sqrt(sqrt(muo/epsilon0)*s)
12 // from eq (1) , we get
13 H=1400/E
14 Eo=E*sqrt(2)
15 Ho=H*sqrt(2)
16 disp (" amplitude of electric field is Eo="+string(Eo)
        +"V/m")
17 disp (" amplitude of magnetic field is Ho="+string(Ho)
        +"amp-turn/m")
```

Scilab code Exa 12.11 skin depth

```
1 clc
2 // to calculate skin depth
3 f =10^8 // frequency
4 sigma =3*10^7 // conductivity of the medium
5 muo =4*%pi*10^-7 // permeability of free space
6 del=sqrt(2/(2*%pi*f*sigma*muo))
7 disp (" skin depth is del="+string(del)+"m")
```

Scilab code Exa 12.12 frequency and show that frequencies can be considered as good conductor

```
1  clc
2  //to calculate frequency
3  muo=4*%pi*10^-7                  //permeability of free
        space
4  sigma=4.3   // in mhos/m
5  del=0.1        //skin depth in m
6  f=2/(2*%pi*muo*del^2)
7  disp("frequency is f="+string(f)+"Hz")
8  //value of frequency is given incorrect in the book
9  //show that for frequencies less than 10^8 ,it can
        be considered as good conductor
10 epsilon=80*8.854*10^-12
11 f=10^8                                         //
        frequency in Hz
12 sigma=4.3
13 //formula is sigma/(omega*epsilon)>4.3/(2*%pi
        *10^8*80*epsilon)
14 sigma1=sigma/(2*%pi*f*epsilon)   //where sigma1=sigma
        /(omega*epsilon)
15 disp("sigma1="+string(sigma1)+"unitless")
16 //the ocean water to be good conductor ,the value of
        sigma/(omega*epsilon) should be greater than 1
```

Scilab code Exa 12.13 penetration depth

```
1  clc
2  //to show that for frequency <10^9 Hz ,a sample of
        silicon will act like a good conductor
3  sigma=200 //in mhos/m
4  omega=2*%pi*10^9
5  epsilon0=8.85*10^-12                  //permittivity in
        free space
6  epsilon=12*epsilon0
7  sigma1=sigma/(omega*epsilon)              //sigma1=sigma
        /(omega*epsilon)
```

```
8  disp("sigma1="+string(sigma1)+"unitless")
9  //if sigma/(omega*epsilon) is greater than 1 ,
       silicon is a good conductor at frequency <10^9 Hz
10 //to calculate penetration depth
11 f=10^6 //frequency in Hz
12 muo=4*%pi*10^-7          //permeability of free space
13 sigma=200
14 del=sqrt(2/(2*%pi*f*muo*sigma))
15 disp("penetration depth is del="+string(del)+"m")
```

Scilab code Exa 12.14 conduction current and displacement current densities

```
1  clc
2  //to calculate conduction current and displacement
       current densities
3  sigma=10^-3          //conductivity in mhos/m
4  E=4*10^-6           //where E=4*10^-6*sin(9*10^9t) v/m
5  J=sigma*E
6  disp("conduction current density is J="+string(J)+"
       sin(9*10^9t)    A/m")
7  epsilon0=8.85*10^-12                //permittivity in
       free space
8  epsilonr=2.45                          //relative
       permittivity
9  //formula is epsilon0*epsilonr*(delE/delt)
10 //delE/delt=4*10^-6*9*10^9*cos(9*10^9*t)
11 Jd=epsilon0*epsilonr*4*10^-6*9*10^9
12 disp("displacement current density is Jd="+string(Jd
       )+"cos(9*10^9*t)   A/m^2")
```

Chapter 13

Superconductivity

Scilab code Exa 13.1 value of T

```
1 clc
2 //to calculate value of Temperature
3 Bc=105*10^3 //magnetic field in amp/m
4 Bo=150*10^3 //critical field of the metal in amp/m
5 Tc=9.2 //critical temperature of the metal in K
6 T=Tc*sqrt(1-(Bc/Bo))
7 disp("value of temperature is T="+string(T)+"K")
```

Scilab code Exa 13.2 temperature and critical current density at the temperature

```
1 clc
2 //to calculate temperature
3 Tc=7.18 //critical temperature in K
4 Bc=4.5*10^3 //critical field in A/m
5 Bo=6.5*10^3 //critical magnetic field in A/m
6 T=Tc*sqrt(1-(Bc/Bo))
7 disp("temperature is T="+string(T)+"K")
```

```
 8  //to calculate critical current density at that
       temperature
 9  r=1*10^-3 //diameter of the wire in mm
10  TJc=(Bc*2*%pi*r)/(%pi*r^2)
11  disp("the critical current density at that
       temperature is TJc="+string(TJc)+"A/m^2")
```