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

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Book Description

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

Contents

List of Scilab Codes

Chapter 1

Relativistic Mechanics

Scilab code Exa 1.1 `length of the bar`

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

Scilab code Exa 1.2 `velocity of rocket`

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

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

Scilab code Exa 1.4 `percentage contraction of rod`

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

Scilab code Exa 1.7 `velocity of circular lamina`

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

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

Scilab code Exa 1.8 speed of clock

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

Scilab code Exa 1.9 distance travelled by beam

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

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

Scilab code Exa 1.10 distance travelled by particle

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

Scilab code Exa 1.11 speed

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

Scilab code Exa 1.12 `velocity of beta particle`

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

Scilab code Exa 1.13 `velocity of B with respect to A`

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

Scilab code Exa 1.14 `velocity in laboratory frame`

```
clc
```

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

Scilab code Exa 1.17 `resultant velocity`

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

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

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

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

Scilab code Exa 1.19 `velocity of particle`

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

```
//E=3 moc^2=mc^2 or m=3 mo (given that total energy
    of the particle is thrice its rest energy)
m=3 // relativistic mass
//formula is v=c sqrt(1-(mo/m)^2)
v=sqrt(c^2*(1-(1/m)^2))
disp("velocity of the particle is v="+string(v)+"m/s
    ")
```

Scilab code Exa 1.20 mass and speed of an electron

```
clc
//to calculate mass(m),speed(v) of an electron
K=1.5*10^6*1.6*10^-19 //kinetic energy(J)
m0=9.11*10^-31 //rest mass of an electron(kg)
c=3*10^8 // velocity of light in vacuum(m/s)
m=(K/c^2)+m0 //relativistic kinetic energy(k=(m-mo)c
    ^2)
disp("mass is m="+string(m)+"kg ")
v=c*sqrt(1-m0^2/m^2)
disp("speed of an electron is v="+string(v)+"m/s")
```

Scilab code Exa 1.21 work to be done

```
clc
//to calculate work to be done
E=0.5*10^6 //rest energy of electron (MeV) E=m0*c^2
v1=0.6*3*10^8 //speed of electron in (m/s)
v2=0.8*3*10^8
c=3*10^8 //speed of light in (m/s)
K1=E*((1/sqrt(1-v1^2/c^2))-1) //kinetic energy in (
    eV)
K2=E*((1/sqrt(1-v2^2/c^2))-1)
w=(K2-K1)*1.6*10^-19
```

```
disp("amount of work to be done is w="+string(w)+"J"
   )
```

Scilab code Exa 1.22 speed

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

Scilab code Exa 1.23 speed of rocket and electron

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

Scilab code Exa 1.24 velocity

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

Scilab code Exa 1.25 kinetic energy and momentum of electron

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

Scilab code Exa 1.26 proton gain in mass

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

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

Scilab code Exa 1.27 speed and mass of electron

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

Chapter 2

interference

Scilab code Exa 2.2 `ratio of intensity`

```
clc
//to calculate ratio of intensity
//I1/I2=1/25
//formula is a1/a2=sqrt(I1/I2)=1/5
a2=5 //a2=5*a1
a1=1
I=((1+5)^2)/((1-5)^2)
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")
//answer is given in terms of ratio
```

Scilab code Exa 2.3 `ratio of intensity`

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

```
//the intensity at any pont is I=a1^2+a2^2+2*a1*a2*
    cos del
//let a1=a2=a
//phase difference del is 0
//then I0=a^2+a^2+2*a*a*cos 0
//we get I0=4a^2
I0=4 //intensity
//path difference is lemda/8
//phase difference =2*%pi/lemda*path difference=%pi
    /4
//I1=a^2+a^2+2a*a*cos %pi/4
//I1=3.414a^2
I1=3.414
intensity=I1/I0
disp(" ratio of intensity ="+string(intensity)+"
    unitless")
```

Scilab code Exa 2.4 `ratio of intensity`

```
clc
//to calculate ratio of maximum intensity to minimum
     intensity
//formula is I1/I2=a1^2/a2^2=100/1
//a1/a2=10/1
a1=10  //a1=10*a2
a2=1
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")
//answer is given in terms of ratio in the book
```

Scilab code Exa 2.5 `relative intensities`

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

Scilab code Exa 2.7 `distance between two coherent sources`

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

Scilab code Exa 2.8 `fringe width`

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

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

Scilab code Exa 2.9 wavelength of light

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

Scilab code Exa 2.10 thickness of glass plate

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

Scilab code Exa 2.11 refractive index of sheet

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

Scilab code Exa 2.12 refrctive index of mica

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

Scilab code Exa 2.13 intensity and lateral shift

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

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

Scilab code Exa 2.14 spacing between slits

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

Scilab code Exa 2.15 distance

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

```
twod=0.2 //distance between the slits in cm
D=120 //distance between the plane of the slits and
   the screen in cm
n=3
X3=D*n*lambda/twod
disp("the distance of the third bright fringe from
   the central maximum is X3="+string(X3)+"cm")
//to calculate the least distance from the central
   maximum
lambda1=6.5*10^-5 //wavelength in cm
lambda2=5.2*10^-5 //wavelength in cm
//Xn=Dnlambda1/2d=D(n+1)lambda2/2d
//we get ,
n=lambda2/(lambda1-lambda2)
disp("n="+string(n)+" unitless")
Xn=D*n*lambda1/twod
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 fr

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

```
n1=n*lambda/(5000*10^-8)
disp("the order will be visible is n1="+string(n1)+"
    unitless")
//to calculate distance between the two coherent
    sources
D=100 //distance in m
lambda=6000*10^-8 //wavelength in cm
omega=0.05 //distance between two consecutive bright
     fringes on the screen in cm
twod=D*lambda/omega
disp("the distance between the coherent sources is
    twod="+string(twod)+"cm")
//to calculate wavelength
Xn=1 //distance of fourth bright fringe from the
    central fringe in cm
twod=0.02 //distance between the two coherent
    sources in cm
n=4
D=100 //distance in cm
lambda=Xn*twod/(n*D)
disp("the wavelength of light is lambda="+string(
    lambda)+"cm")
//to calculate wavelength
//position of nth bright fringe from the centre of
    the central fringe is Xn=D*n*lambda/2d------eq(1)
//fringe width umega=D*lambda/2d
    ------------------------eq(2)
//from eq(1) and eq(2) we get, Xn=n*omega
//for 11th bright fringe X11=11*omega
//position for nth dark fringe Xn'=(2n+1)D*lambda/4d
//X4'=(7/2)*omega
//distance between 11th and 4th dark fringe =0.8835
    cm
//we get
omega=0.1178 //in cm
twod=0.05 //distance between slis in cm
D=100 // distance in cm
lambda=omega*twod/D
```

```
disp("the wavelength of light is lambda="+string(
   lambda)+"cm")
//to calculate changed fringe width
//X10-X0=10*omega
//given that X10-X0=14.73-12.34=2.39mm
omega=0.239 //in mm
lambda=6000 //wavelength in angstrom
lambda1=5000 //lambda'=5000 angstrom
omega1=omega*lambda1/lambda
disp("the changed fringe width is omega1="+string(
   omega1)+"mm")
//to calculate thickness of mica sheet
n=3
mu=1.6 //refractive index(unitless)
lambda=5.89*10^-5 //wavelength in cm
t=n*lambda/(mu-1)
disp("the thickness of mica sheet is t="+string(t)+"
   cm")
//answer of thickness is given wrong in the book
   =0.002945 cm
```

Scilab code Exa 2.17 thickness of plate

```
clc
//to calculate the smallest thickness of the plate
mu=1.5 //refractive index(unitless)
r=60*%pi/180 //angle of refraction in radians
lambda=5890*10^-10 //wavelength in m
n=1
//formula is t=n*lambda/(2*mu*cosr) where cosr=0.5
t=n*lambda/(2*mu*0.5)
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

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

Scilab code Exa 2.19 thickness of film

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

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

Scilab code Exa 2.20 thickness of film

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

Scilab code Exa 2.21 angle of wedge

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

Scilab code Exa 2.22 wavelength of light

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

Scilab code Exa 2.23 wavelength of light

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

Scilab code Exa 2.24 refractive index of liquid

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

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

Scilab code Exa 2.25 radius and thickness

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

Scilab code Exa 2.26 distance

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

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

Scilab code Exa 2.27 `radius and thickness`

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

Scilab code Exa 2.28 `diameter of ring`

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

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

Scilab code Exa 2.29 `diameter of ring`

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

Scilab code Exa 2.30 `difference of square of diameters`

```
clc
```

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

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

Scilab code Exa 3.2 wavelength of light

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

Scilab code Exa 3.3 width of slit

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

Scilab code Exa 3.4 wavelength of incident light

```
clc
//to calculate wavelength of incident light
//direction of minima is given by e*sintheta=+m*lambda
//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)
//theta=Y/d........................eq(2)
e=0.02 //in cm
Y=0.5         //position of first minima from the central maxima in cm
d=200             //distance of screen from the slit in cm
//from eq(1) and eq(2) ,we get
lambda=e*Y/d
disp("wavelength of incident light is lambda="+string(lambda)+"cm")
```

Scilab code Exa 3.6 values of lambda1 and lambda2

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

```
//from eq(1) and eq(2),we get e*sintheta=4*lambda1
    =5*lambda2....eq(3)
y=0.5              //in cm
f=100               //in cm
theta=y/f                       //in radian
sintheta=theta //theta is very small
e=0.05         //width of slit in cm
lambda1=e*sintheta/4
disp("lambda1="+string(lambda1)+"cm")
//from eq(3) we get,
lambda2=4*lambda1/5
disp("lambda2="+string(lambda2)+"cm")
```

Scilab code Exa 3.7 half angular width

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

Scilab code Exa 3.8 angle

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

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

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

Scilab code Exa 3.10 wavelength of light and missing orders

```
clc
```

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

Scilab code Exa 3.11 wavelength of spectral line

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

Scilab code Exa 3.12 difference in deviations

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

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

Scilab code Exa 3.13 orders

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

Scilab code Exa 3.14 number of lines per cm

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

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

Scilab code Exa 3.15 orders of spectrum

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

Scilab code Exa 3.17 angle of diffraction

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

```
lambda=5000*10^-8                    //wavelength of light in cm
eplusd=1/5000        // in cm
theta=asind(n*lambda/(eplusd))
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

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

Scilab code Exa 3.19 spectral line

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

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

Scilab code Exa 3.20 grating element

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

Scilab code Exa 3.21 angle of diffraction and absent spectra

```
clc
```

```
//to calculate angle of diffraction for third order
    spectrum and absent spectra if any
n=3
lambda=6000*10^-8
eplusd=1/200
theta=asind(n*lambda/eplusd)
disp("angle of refraction is theta="+string(theta)+"
    degree")
d=0.0025
e=eplusd-d //width of wire in cm
m=1
n=eplusd*m/e
disp("order of absent spectrum is n="+string(n)+"
    unitless")
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`

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

Scilab code Exa 3.23 dispersive power

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

Scilab code Exa 3.24 orders

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

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

Scilab code Exa 3.26 aperture

```
clc
//to calculate aperture of the objective of a
    telescope
lambda=6*10^-5 //wavelength of light in cm
dtheta=4.88*10^-6 // in radians
a=1.22*lambda/dtheta
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

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

Scilab code Exa 3.28 `numerical aperture`

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

Scilab code Exa 3.29 `resolving power`

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

Scilab code Exa 3.30 maximum resolving power

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

Scilab code Exa 3.31 minimum number of lines

```
clc
//to calculate minimum number of lines in a grating
lambda1=5890
              //wavelengh in angstrom
lambda2=5896
dlambda=6 //smallest wavelength difference in
    angstrom
n=2 //order of spectrum
lambda=(lambda1+lambda2)/2 //average wavelength in
    angstrom
RP=lambda/dlambda //RP=resolving power
N=RP/n
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

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

```
clc
//distance between the centres of  images of two
   stars
lambda=5500*10^-8          //wavelength of light in
   cm
f=4*10^2                  //focal length of telescope
   objective in cm
a=0.01*10^2            //diameter in cm
X=1.22*lambda*f/a
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

```
clc
```

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

Scilab code Exa 3.35 smallest angle between two stars

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

Scilab code Exa 3.36 limit of resolution of telescope

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

Scilab code Exa 3.37 resolving limit of microscope

```
clc
```

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

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

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

Scilab code Exa 3.39 resolving power and smallest wavelength

```
clc
//to calculate resolving power in the second order
N=6*10^4 //N=total number of lines on grating
n=2 //order of spectrum
RP=n*N //RP=resoling power
disp("the resolving power is RP="+string(RP)+"unitless")
```

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

Chapter 4

Polarisation

Scilab code Exa 4.1 compare intensities

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

Scilab code Exa 4.2 angle of refraction

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

Scilab code Exa 4.3 polarising angle and angle of refraction

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

Scilab code Exa 4.4 thickness of half wave plate

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

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

Scilab code Exa 4.5 thickness of quarter wave plate

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

Scilab code Exa 4.6 thickness of doubly refracting plate

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

Scilab code Exa 4.7 angle of rotation

```
clc
```

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

Scilab code Exa 4.8 specific rotation

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

Scilab code Exa 4.9 strength of solution

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

Scilab code Exa 4.10 difference in the refractive indices

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

Scilab code Exa 4.11 optical rotation

```
clc
//to calculate optical rotation
//let theta' be the optical rotation by a solution
   of strength c' in a tube of length l' then
//we get 10*theta'/l'*c'=10*theta/l*c
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
l1=30  //where l1=l'
           //length in cm
l=20
theta=13 //degree
//formula is theta'=l'*c'*theta/(l*c)
theta1=l1*c*theta/l
disp("optical rotation is theta1="+string(theta1)+"
   degree")
```

Scilab code Exa 4.12 `specific rotation`

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

Scilab code Exa 4.13 `length of solution`

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

Scilab code Exa 4.14 `rotation of plane of polarisation`

```
clc
//to calculate rotation of plane of polarisation of light
mur=1.53914
                    //refractive index
mul=1.53920
```

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

Scilab code Exa 4.15 percentage purity of sugar sample

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

Chapter 5

Lasers

Scilab code Exa 5.1 area of spot on the moon

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

Scilab code Exa 5.2 angular spread and areal spread

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

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

Scilab code Exa 5.3 number of oscillations and coherence time

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

Scilab code Exa 5.4 area and intensity of image

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

```
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

```
clc
//to calculate critical angle for core−cladding
   interface
n1=1.5
n2=1.45
thetac=asind(n2/n1)
theta1=90-thetac
disp("critical angle for core−cladding interface is
   theta1="+string(theta1)+"degree")
//to calculate acceptance angle in air for fibre and
    corresponding angle of obliquences
na=1
thetaa=asind(n1*0.26/na)
disp("acceptance angle thetaa="+string(thetaa)+"
   degree")
//to calculate numerical aperture
NA=((n1+n2)*(n1-n2))^(1/2)
disp("numerical aperture of fibre is NA="+string(NA)
   +"unitless")
//to calculate % of light
per=(NA)^2*100
```

```
disp("% of light collected is per="+string(per)+"%")
```

Scilab code Exa 6.2 numerical aperture and critical angle

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

Scilab code Exa 6.3 refractive index and normalised frequency and total number of

```
clc
//to calculate refractive index of the cladding
a=35*10^-6 //core diameter in micrometre
//formula is del=(n1-n2)/n1
//we get
del=1.5/100
n1=1.46 //refractive index of the fibre
lambda=0.85*10^-6 //wavelength in micrometer
n2=n1-del*n1
disp("refractive index is n2="+string(n2)+"unitless"
   )
```

```
//to calculate normalised frequency V number of the
    fibre
V=(2*%pi*a*n1*0.173)/lambda
disp("normalised frequency V number of the fibre is
    V="+string(V)+" unitless")
//to calculate total number of guided modes in the
    fibre
M=(V^2)/2
disp("total number of guided modes in the fibre is M
    ="+string(M)+"modes")
```

Scilab code Exa 6.4 cutoff wavelength

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

Scilab code Exa 6.5 maximum and minimum value of phase constant

```
clc
//to calculate maximum and minimum value of phase
    constant
lambda=0.8*10^-6 //wavelength in micrometre
n1=1.6*10^-6
```

```
                    //refractive indices in
                       micrometre
n2=1.44*10^-6
maximum=(2*%pi*n1)/lambda
minimum=(2*%pi*n2)/lambda
disp("maximum value of phase constant is maximum="+
   string(maximum)+"radian/micrometre")
disp("minimum value of phase constant is minimum="+
   string(minimum)+"radian/micrametre")
```

Chapter 7

Wave Mechanics

Scilab code Exa 7.1 de broglie wavelength

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

Scilab code Exa 7.2 de broglie wavelength

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

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

Scilab code Exa 7.4 `wavelength`

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

Scilab code Exa 7.5 `Kinetic energy of electron`

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

Scilab code Exa 7.6 `wavelength of electron`

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

Scilab code Exa 7.7 de broglie wavelength of electron

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

Scilab code Exa 7.9 energy of neutron

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

Scilab code Exa 7.10 wavelength and number of photons

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

Scilab code Exa 7.11 uncertainity in position of electron

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

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

Scilab code Exa 7.12 uncertainity in velocity

```
clc
//to calculate minimum uncertainity in the velocity
delxmax=10^-8 //maximum uncertainity in position in
    m
h=6.626*10^-34 //planck's constant
delpmin=h/(2*%pi*delxmax) //minimum uncertainity in
    momentum in kg-m/s^2
m=9*10^-31 //mass of an electron in kg
delvmin=delpmin/m
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 p

```
clc
//to calculate uncertainity in the momentum of the
    parcticle
h=6.626*10^-34 //planck's constant J-s
delx=0.01*10^-2 //uncertainity in position in m
delp=h/(2*%pi*delx)
disp("uncertainity in the momentum of the parcticle
    is delp="+string(delp)+"kg-m/s^2")
//to calculate uncertainity in the velocity of an
    electron
m=9*10^-31 //mass of an electron in kg
```

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

Scilab code Exa 7.14 uncertainity in position of electron

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

Scilab code Exa 7.15 uncertainity in frequency

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

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

Scilab code Exa 7.16 minimum error

```
clc
//to calculate uncertainity in the energy
h=6.63*10^-34 //plank's constant in J-s
delt=2.5*10^-14 //uncertainity in time in s
delE=h/(2*%pi*delt*1.6*10^-19)
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

```
clc
//to calculate time required for the atomic system
//delE=h*c*dellambda/lambda^2 -----eq(1)
//delE*delt=h/2*%pi-----------eq(2)
dellambda=10^-14
c=3*10^8
lambda=6*10^-7
//from eq(1)and eq(2),we get
delt=(lambda^2)/(2*%pi*c*dellambda)
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

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

Scilab code Exa 7.19 `uncertainity in velocity`

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

Scilab code Exa 7.20 `uncertainity in frequency and energy of electron`

```
clc
//to calculate uncertainity in frequency
h = 3.16152649*10^-26;
delt=10^-8 //uncertainity in time
delnu=1/(2*%pi*delt)
```

```
disp("minimum uncertainity in the frequency of a
   photon is delnu="+string(delnu)+"sec^-1")
//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
delx=5*10^-15 //uncertainity in position
delp=h/(2*2*%pi*delx) //uncertainbity in momentum
c=3*10^8 ///speed of light in m/s
E=delp*c
disp("energy of an electron is E="+string(E)+"J")
```

Scilab code Exa 7.22 probability of finding the particle

```
clc
//to calculate probability of finding the particle
a=25*10^-10//width in angstrom
//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
chix=sqrt(2/a)*sin(%pi*(a/2)/a)
delx=5*10^-10 //interval in angstrom
P=delx*chix^2
disp("probability of finding the particle is P="+
   string(P)+"unitless")
```

Scilab code Exa 7.24 energy of electron

```
clc
//to calculate energy of an electron
n=1 //least energy of the particle
h=6.63*10^-34 //planck's constant in Js
m=9.11*10^-31 //mass of electron in kg
a=10^-10 //width in angstrom
```

```
E=(n^2)*(h^2)/(8*m*(1.602*10^-19)*a^2)
disp("energy of an electron moving in one dimension
   in an infinitely high potential box is E="+string
   (E)+"eV")
//the answer is given wrong in the book E=5.68 eV
```

Scilab code Exa 7.26 probability of particle

```
clc
//to calculate probability
x1=0.45 //x1=0.45*L
x2=0.55          //x2=0.55*L
n=1                         //for ground state
//formula is P=integrate('(2/L)*sin(n*%pi*x)^2),'x',
   x1,x2)
P1=integrate('2*(sin(n*%pi*x)^2)','x',x1,x2)
disp("P1="+string(P1)+" unitless")
probability1=P1*100
disp("probability for the ground states is
   probability1 ="+string(probability1)+"%")
n=2              //for first excited state
P2=integrate('2*(sin(n*%pi*x)^2)','x',x1,x2)
disp("P2="+string(P2)+" unitless")
probability2=P2*100
disp("probability for first excited states is
   probability2="+string(probability2)+"%")
```

Scilab code Exa 7.28 energy of neutron

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

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

Scilab code Exa 7.29 zero point energy

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

Scilab code Exa 7.30 zero point energy

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

Scilab code Exa 7.31 `frequency of vibration`

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

Chapter 8

X Rays

Scilab code Exa 8.1 value of plancks constant

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

Scilab code Exa 8.2 maximum frequency

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

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

Scilab code Exa 8.3 `number of electrons and speed`

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

Scilab code Exa 8.4 `longest wavelength`

```
clc
//to calculate wavelength
n=2 //second order for longest wavelength
d=2.82*10^-10 // spacing in angstrom
sintheta=1
lambdamax=2*d*sintheta/n
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

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

Scilab code Exa 8.6 wavelength

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

Scilab code Exa 8.7 thickness

```
clc
//to calculate thickness
//mass absorption coefficient mum of an absorber is
   related with linear absorption coefficient mu and
    density of the material rho is given by
//mu=rho*mum=2.7*0.6=1.62 cm^-1
mu=1.62
//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
//where I/Io=20
//put above values in the  below equation , we get
x=(2.3026*(log(20)/log(10)))/1.62
disp("thickness is x="+string(x)+"cm")
```

Scilab code Exa 8.8 atomic number

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

Scilab code Exa 8.9 wavelength of X Rays

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

Scilab code Exa 8.10 wavelength of second X Ray beam

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

Scilab code Exa 8.11 wavelength of X Ray used

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

Scilab code Exa 8.12 possible spacing of the set of planes

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

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

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

Scilab code Exa 8.14 wavelength and energy of photon

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

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

Scilab code Exa 8.15 wavelength and direction of electron

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

```
clc
//to calculate wavelength of two X-rays
```

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

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

Scilab code Exa 9.2 charge on capacitor

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

Scilab code Exa 9.3 resultant voltage

```
clc
//to calculate voltage
A=6.50*10^-4 //area in m^2
Q=2*10^-10 //charge in C
d=4*10^-3 //plate separation in m
epsilon0=8.854*10^-12
epsilonr=3.5 //dielectric constant
V=Q*d/(epsilon0*epsilonr*A)
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

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

Scilab code Exa 10.2 current

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

Scilab code Exa 10.3 magnetic moment of rod

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

```
clc
//to calculate flux density,magnetic intensity,
   permeability of iron
phi=2*10^-6 //flux in the ring in weber
A=10^-4 //cross-sectional area in m^2
```

```
B=phi/A
disp("flux density is B="+string(B)+"weber/m^2")
N=200 //number of turns
i=0.30 //current flows in the windings in A
l=0.2 //length in m
H=N*i/l
disp("magnetic intensity is H="+string(H)+"A-turn/m"
  )
mu=B/H
disp("permeability is mu="+string(mu)+"weber/A-m")
muo=4*%pi*10^-7
mur=mu/muo
disp("relative permeability is mur="+string(mur)+"
  unitless")
```

Scilab code Exa 10.5 number of ampere turns

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

Scilab code Exa 10.6 relative permeability

```
clc
//to calculate relative permeability of the medium
phi=1.5*10^-3 //magnetic flux in weber
```

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

Scilab code Exa 10.7 magnetising current

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

Chapter 11

Ultrasonics

Scilab code Exa 11.1 `fundamental frequency`

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

Chapter 12

Electromagnetics

Scilab code Exa 12.1 electric flux and flux

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

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

Scilab code Exa 12.3 electric field

```
clc
//to calculate electric field at a point on earth vertically below the wire
lambda=10^-4 //wavelength in coulomb/m
r=4 //radius in m
epsilon0=8.854*10^-12
E=2*lambda/(4*%pi*epsilon0*r)
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

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

Scilab code Exa 12.5 force per unit area

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

Scilab code Exa 12.6 charge

```
clc
//to calculate charge
//let charge be q coulomb ,then the surface density
    of charge i.e. sigma=q/(4*%pi*r^2).............
    eq(1)
//outward pull per unit area =sigma^2/(2*epsilon0)
    ............eq(2)
//put eq(1) in eq(2),we get q^2/(4*%pi*r^2)^2*(2*
    epsilon0)..............eq(3)
//pressure due to surface tension =4*T/r...........
    eq(4)
T=27
r=1.5*10^-2
epsilon0=8.85*10^-12
//equate eq(3) and eq(4),we get
q=sqrt(4*T*((4*%pi*r^2)^2)*2*epsilon0/r)
disp("charge is q="+string(q)+"coulomb")
//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

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

Scilab code Exa 12.8 average values of intensities

```
//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
clc
//to calculate average values of intensities of
  electric and magnetic fields of radiation
//energy of lamp=1000 J/s
//area illuminated =4*%pi*r^2=16*%pi m^2
//energy radiated per unit area per second =1000/16*
  %pi
//from poynting theorem |s|=|E*H|=E*H            eq
  (1)
s=1000/(16*%pi)
muo=4*%pi*10^-7                //permeability of free
  space
epsilon0=8.85*10^-12              //permittivity in
  free space
//E/H=sqrt(muo/epsilon0)        eq(2)
//from eq(1) and eq(2),we get
E=sqrt(s*sqrt(muo/epsilon0))
H=s/E
disp("average value of intensity of electric fields
  of radiation is E="+string(E)+"V/m")
disp("average value of intensity of magnetic fields
  of radiation is H="+string(H)+"ampere-turn/m")
//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`

```
clc
//to calculate amplitudes of electric and magnetic
  fields of radiation
//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
   )
//it is given that energy received by earth's
   surface is
s=1400                    //|s|=2 cal min^-1 cm^-2
muo=4*%pi*10^-7 //permittivity of free space
epsilon0=8.85*10^-12 //permeability of free space
//E*H=1400                              eq(1)
//E/H=sqrt(muo/epsilon0)                     eq(2)
//from eq(1) and eq(2) ,we get
E=sqrt(sqrt(muo/epsilon0)*s)
//from eq(1) ,we get
H=1400/E
Eo=E*sqrt(2)
Ho=H*sqrt(2)
disp("amplitude of electric field is Eo="+string(Eo)
   +"V/m")
disp("amplitude of magnetic field is Ho="+string(Ho)
   +"amp-turn/m")
```

Scilab code Exa 12.11 skin depth

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

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

```
clc
```

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

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

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

Scilab code Exa 12.14 conduction current and displacement current densities

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

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

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

```
clc
//to calculate temperature
Tc=7.18 //critical temperature in K
Bc=4.5*10^3  //critical field in A/m
Bo=6.5*10^3 //critical magnetic field in A/m
T=Tc*sqrt(1-(Bc/Bo))
disp("temperature is T="+string(T)+"K")
//to calculate critical current density at that
   temperature
```

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