

Scilab Textbook Companion for
Engineering Physics
by P. V. Naik¹

Created by
Sruthi Namburi
B-tech
Computer Engineering
CVSR college of engineering
College Teacher
Pawan Kumar
Cross-Checked by

May 25, 2016

¹Funded by a grant from the National Mission on Education through ICT, <http://spoken-tutorial.org/NMEICT-Intro>. This Textbook Companion and Scilab codes written in it can be downloaded from the "Textbook Companion Project" section at the website <http://scilab.in>

Book Description

Title: Engineering Physics

Author: P. V. Naik

Publisher: Pearson Publications (India)

Edition: 1

Year: 2004

ISBN: 8129705206

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	4
1 Acoustics	5
2 Crystal structures	11
4 Interference	16
5 Diffraction	23
6 Polarisation	29
7 Motion of charged particle	35
8 Magnetic Materials and Specroscopy	43
9 Quantum Theory	48
10 Quantum Mechanics	56
11 Nuclear Radiations and Detectors	63
13 Optical Fibre	72

List of Scilab Codes

Exa 1.1	To calculate the intensity	5
Exa 1.2	distance at which sound reduces to a level	5
Exa 1.3	Determination of total absorption in hall	6
Exa 1.4	average absorption coefficients of surface	6
Exa 1.5	determination of frequency of ultrasonic sound waves	7
Exa 1.6	To determine the thickness of crystal	7
Exa 1.7	To calculate the output power	8
Exa 1.8	To calculate the output power	8
Exa 1.9	To determine reverberation time	9
Exa 1.10	To determine the thickness of crystal	9
Exa 1.11	ratio of new to old frequencies	10
Exa 2.1	To determine lattice parameter	11
Exa 2.2	free volume per unit cell	11
Exa 2.3	To determine ratio of vacancies	12
Exa 2.4	ratio of number of vacancies to number of atoms	12
Exa 2.5	spacing of 111 planes	13
Exa 2.6	To calculate density of the structure	13
Exa 2.7	To calculate atomic radius	14
Exa 2.8	To determine lattice parameter	14
Exa 2.9	Density of free electrons	15
Exa 2.10	To determine lattice parameter	15
Exa 4.1	Wavelengths absent in reflected light	16
Exa 4.2	To calculate thickness of air film	16
Exa 4.3	To calculate the bandwidth	17
Exa 4.4	Refractive index of liquid	17
Exa 4.5	Diameter of ninth dark ring	18
Exa 4.6	Wavelength of light used	18
Exa 4.7	To determine thickness of the plate	19

Exa 4.8	Minimum thickness of film	19
Exa 4.9	Thickness of the film	20
Exa 4.10	To calculate the wedge angle	20
Exa 4.11	Refractive index of liquid	21
Exa 4.12	Wavelength of light used	21
Exa 4.13	Wavelength with high transmission	22
Exa 5.1	To determine the width of the slit	23
Exa 5.2	To determine central band	23
Exa 5.3	To determine width of slit	24
Exa 5.4	Distance between central maximum and fourth dark fringe	24
Exa 5.5	Ratio of intensities of central and secondary maximum	25
Exa 5.6	Minimum number of lines per cm	25
Exa 5.7	Angle at which first minimum will be observed	26
Exa 5.8	To determine width of the slit	26
Exa 5.9	Wavelength of light used	26
Exa 5.10	Wavelength of spectral line	27
Exa 5.11	Minimum grating element required	27
Exa 6.1	To determine angle of refraction	29
Exa 6.2	Percentage of incident unpolarised light	29
Exa 6.3	Angle between planes	30
Exa 6.4	Intensities of ordinary and extraordinary light	30
Exa 6.5	Thickness of quarter wave plate	31
Exa 6.6	To determine the refractive index	31
Exa 6.7	To calculate the refractive index	32
Exa 6.8	Angle made by the plane of vibration of the incident light with the optic axis	32
Exa 6.9	Phase difference between O and E rays	33
Exa 6.10	Wavelength of light incident on quartz plate	33
Exa 7.1	Kinetic energy and speed of electron	35
Exa 7.2	Vector displacement of electron	35
Exa 7.3	Time required for the proton to reach maximum height	36
Exa 7.4	Orbital speed of proton	37
Exa 7.5	Pitch of the helix	37
Exa 7.6	To calculate the displacement produced	38
Exa 7.7	Displacement of electron beam spot on the screen	39
Exa 7.8	Separation on the photographic plate	39
Exa 7.9	Intensity of electric field	40

Exa 7.10	Charge to mass ratio of the particle	40
Exa 7.11	Magnetic field required to bend a beam	41
Exa 7.12	To determine the magnetic field	41
Exa 7.13	To determine the magnetic field	42
Exa 8.1	To determine temperatue	43
Exa 8.2	Magnetisation of paramagnetic salt	43
Exa 8.3	Zeeman shift in wave length	44
Exa 8.4	To determine temperature	45
Exa 8.5	Magnetisation of paramagnetic salt	45
Exa 8.6	To calculate the magnetic field	46
Exa 8.7	To calculate the magnetic field	46
Exa 8.8	To determine e m ratio	47
Exa 9.1	Power radiated by the filament	48
Exa 9.2	To calculate the number of photons	49
Exa 9.3	Maximum kinetic energy of photoelectron	49
Exa 9.4	To determine the potential difference	50
Exa 9.5	Shortest wavelength of X rays	50
Exa 9.6	To calculate wavelength of line	51
Exa 9.7	Distance between atomic planes	51
Exa 9.8	Wavelength of X rays	52
Exa 9.9	To determine the power of laser	52
Exa 9.10	Work function of the surface	53
Exa 9.11	To calculate the accelerating voltage	54
Exa 9.12	Angle of second order Braggs reflections	54
Exa 9.13	Accelerating voltage applied	55
Exa 10.1	To calculate de Broglie wavelength	56
Exa 10.2	To determine the kinetic energy	56
Exa 10.3	To calculate the kinetic energy	57
Exa 10.4	Uncertainty in determining the position	58
Exa 10.5	First 2 energy levels of a particle	58
Exa 10.6	Ground state and first excited state energy	59
Exa 10.7	To determine kinetic energy of electron	59
Exa 10.8	To determine velocity of electron	60
Exa 10.9	To determine the potential difference	61
Exa 10.10	Uncertainty in velocity of electron	61
Exa 10.11	Length of the box for a proton	62
Exa 11.1	To calculate the radius of Li	63
Exa 11.2	Binding energy per nucleon	63

Exa 11.3	minimum energy required to remove a neutron from nucleus	64
Exa 11.4	To determine the Q value of the reaction	65
Exa 11.5	Q value of the reaction and energy of each alpha particle	65
Exa 11.6	To calculate the energy released	66
Exa 11.7	power output of a nuclear reactor	66
Exa 11.8	Amount of U required	67
Exa 11.9	Frequency of oscillator to be used	67
Exa 11.10	To calculate the radius	68
Exa 11.11	To calculate the cyclotron frequency	69
Exa 11.12	To determine the magnetic field	69
Exa 11.13	To determine the magnetic field	70
Exa 11.14	Charge to mass ratio for proton	70
Exa 13.1	Numerical aperture of a fibre	72
Exa 13.2	To determine the acceptance angle	72
Exa 13.3	Number of guided modes	73
Exa 13.4	Signal attenuation per kilometer	73
Exa 13.5	Numerical aperture for the optical fibre	74
Exa 13.6	Number of guided modes	74
Exa 13.7	To determine the mean optical power	75
Exa 13.8	To determine the mean optical power	75
Exa 13.9	To calculate signal attenuation	76

Chapter 1

Acoustics

Scilab code Exa 1.1 To calculate the intensity

```
1 clc();
2 clear;
3 //To calculate intensity of sound
4
5 p=50; //sound waves with output
   power in W
6 r=4; //Distance in m
7 I=p/(4*%pi*r^2) //Intensity in W/m^2
8 printf("Intensity of sound at a distance of 4m from
   the source is %f W/m^2",I);
```

Scilab code Exa 1.2 distance at which sound reduces to a level

```
1 clc();
2 clear;
3 //To determine the distance when intensity or power
   of source of sound changes
4 //Io=10^-12; //Initial intensity of
   sound
```

```

5 //d=50; //d=number of decibels
   given by  $10\log(I_0/I_1)$ 
6 //Therefore  $I_1=10^5 I_0=10^{-7} \text{W/m}^2$ 
7  $I_1=10^{-7}$ ;
8 P=70; //Output power in W
9 r=sqrt(P/(4*(%pi)*I1)) //distance in m
10 printf("The distance at which sound reduces to a
   level of 50dB is %f m",r);

```

Scilab code Exa 1.3 Determination of total absorption in hall

```

1 clc();
2 clear;
3 //To find the total absorption in the hall
4 v=8000; //volume of the hall
5 T=1.5; //Reverberation time in seconds
6 A=(0.161*v)/T //Total absorption time in m^2
   sabine
7 printf("The total reverberation in the hall if
   reverberation time is 1.5s is %f m^2 sabine",A);

```

Scilab code Exa 1.4 average absorption coefficients of surface

```

1 clc();
2 clear;
3 //To determine the average absorption coefficients
   of surfaces
4 l=25; //length of the hall
   in m
5 b=20; //breadth of the hall
   in m
6 h=10; //height of the hall in
   m

```

```

7 V=l*b*h; //Volume of the hall
8 T=4; //Reverberation time in
    s
9 A=(0.161*V)/T ; //Total absorption time
    in m^2 sabine
10 b=A/(2*((l*b)+(b*h)+(l*h))) //b is absorption co-
    efficient
11 printf("The average absorption co-efficients of
    surfaces is %f",b);

```

Scilab code Exa 1.5 determination of frequency of ultrasonic sound waves

```

1 clc();
2 clear;
3 //To determine the frequency of ultrasonic waves
4 Y=77*(10^10); //Youngs
    modulus for quartz in dyne/cm^2
5 rho=2.6; //
    density of quartz in g/cm^3
6 t=0.4; //
    thickness in cm
7 f=((1/(2*t))*sqrt(Y/rho))*10^-3 //
    frequency
8 printf("The frequency of ultrasonic waves produced
    when a quartz plate of thickness 4mm is used is
    %d kHz",f);

```

Scilab code Exa 1.6 To determine the thickness of crystal

```

1 clc();
2 clear;
3 //To determine the thickness of a crystal to produce
    ultrasonic waves

```

```

4 Y=81*(10^10); //Young's
    modulus for barium titanate in dynes/cm^2
5 rho=5.51; //density
    of barium titanate in g/cm^3
6 f=900; //frequency
    of ultrasonic waves in kHz
7 t=((1/(2*f))*sqrt(Y/rho))*10^-2 //thickness
    of crystal
8 printf("The thickness of the crystal to produce
    ultrasonic waves of frequency 900kHz is %f mm",t)
;

```

Scilab code Exa 1.7 To calculate the output power

```

1 clc();
2 clear; //To calculate the output power of the sound
    source
3 r=3; //distance in m
4 I=0.86; //Intensity of sound
    source in W/m^2
5 P=4*(%pi)*r^2*I //Power of the sound
    source
6 printf("The output power of the sound source of
    intensity 0.86 W/m^2 at a distance of 3m is %f W"
,P);

```

Scilab code Exa 1.8 To calculate the output power

```

1 clc();
2 clear;
3 //To determine the output power of the sound source
4 d=60; //Number of decibels given
    by 10*log(I/I0)

```

```

5 I0=10^-12;           //Initial intensity of
   sound
6 I=10^-6;             //since 10log(I/I0)=60
7 r=200;               //distance in m
8 P=4*(%pi)*r^2*I
9 printf("The output power of the sound source at a
   distance of 200m after the intensity reduces to a
   level of 60dB is %f W",P);

```

Scilab code Exa 1.9 To determine reverberation time

```

1 clc();
2 clear;
3 //To calculate the reverberation time
4 V=9250;               //volume of the hall
   in m^3
5 A=900;               //Total absorption in
   m^2 sabine
6 T=(0.161*V)/A       //Reverberation time
   in s
7 printf("The reverberation time in a hall of 9250m^3
   and total absorption 900 m^2 sabine is %f s",T);

```

Scilab code Exa 1.10 To determine the thickness of crystal

```

1 clc();
2 clear;
3 //To determine the thickness of the crystal
4 f1=400;               //Initial frequency
   in kHz
5 f2=500;               //New frequency
6 t1=3;                // initial thickness
   of the crystal

```

```
7 t2=(f1*t1)/f2 //required thickness
8 printf("The required thickness of the crystal is %f
mm",t2 );
```

Scilab code Exa 1.11 ratio of new to old frquencies

```
1 clc();
2 clear;
3 //Determining the ratio of new to old frequencies
4 t1=2; //Initial thickness in mm
5 t2=2.8; //New thickness in mm
6 F=t1/t2 //ratio of new to old
frequencies i.e f2/f1
7 printf("The ratio of new to old frequencies is %f",F
);
```

Chapter 2

Crystal structures

Scilab code Exa 2.1 To determine lattice parameter

```
1 clc();
2 clear;
3 //To determine the lattice parameter
4 d=6.5*10^3; //density of silver
   bromide in Kg/m^3
5 m=187.8; //molecular weight of
   silver bromide
6 M=(4*m)/(6.022*10^26); //mass of ion in unit
   cell in kg. There are 4 molecules per unit cell as
   it is a fcc diatomic structure
7 //d=mass of ions in unit cell/volume of unit cell
8 //6.5*10^3=(1.25*10^-24)/a^3
9 a=((M/d)^(1/3))*10^10 //lattice parameter
10 printf("The lattice parameter is %f A",a);
```

Scilab code Exa 2.2 free volume per unit cell

```
1 clc();
```

```

2 clear;
3 //To determine the free volume per unit cell
4 r=2.3; //atomic
   radius
5 a=(4*r)/sqrt(3);
6 fv=((a)^3-(2*(4/3)*%pi*r^3))*10^-30 //free volume
   in m^3
7 printf("The free volume per unit cell is %e m^3",fv)
   ;

```

Scilab code Exa 2.3 To determine ratio of vacancies

```

1 clc();
2 clear;
3 //To determine the ratio of vacancies
4 k=8.625*10^-5; //Boltzmann
   constant ineV/K
5 //n1000/n500=ln[n1000/n500]=Ev/1000k
6 Ev=1.08; //average
   energy required to create a vacancy in eV
7 N=exp(Ev/(1000*k)) //n1000/n500
8 printf("The ratio of vacancies is %f",N);

```

Scilab code Exa 2.4 ratio of number of vacancies to number of atoms

```

1 clc();
2 clear;
3 //To determine the ratio of the number of vacancies
   to the number of atoms
4 //n500=N*exp(-Ev/500k)
5 k=8.625*10^-5; //
   Boltzmann constant in eV/K

```



```

6 Ev=0.95; //average
   energy required to create a vacancy
7 n=exp(-Ev/(500*k)) //n500/N
8 printf("The ratio of number of vacancies to the
   number of atoms is %e ",n);

```

Scilab code Exa 2.5 spacing of 111 planes

```

1 clc();
2 clear;
3 //To determine spacing of (111) planes in a
   monoatomic fcc structure
4 h=1;
5 k=1;
6 l=1;
7 //d(hkl)=a/sqrt(h^2+k^2+l^2) where "a" is the lattice
   parameter
8 r=0.18; //atomic radius in nm
9 d(111)=(2*sqrt(2)*r)/sqrt((h^2)+(k^2)+(l^2))
10 printf("The spacing of (111) planes in a monoatomic
   structure with atomic radius 0.18 nm is %f nm",d
   (111));

```

Scilab code Exa 2.6 To calculate density of the structure

```

1 clc();
2 clear;
3 //To calculate the density of the structure
4 M=200; //atomic weight
5 a=5; //lattice
   parameter
6 Na=6.022*(10^26);

```

```

7 rho=(2*M)/(Na*(a*10^-10)^3)           //density of the
    structure
8 printf("The density of the bcc structure is %f kg/m
    ^3",rho);

```

Scilab code Exa 2.7 To calculate atomic radius

```

1 clc();
2 clear;
3 //To determine the atomic radius
4 //Free volume=a^3-[(4/3)*pi*r^3]; for sc ,a=2r
5 //Therefore free volume =(2r)^3-[(4/3)*pi*r^3]
6 fv=30.48*10^-30;                       // free
    volume per unit cell
7 r=(fv/(8-(4/3)*%pi))^(1/3)*(10^10)     // atomic
    radius
8 printf("The atomic radius is %f A",r);

```

Scilab code Exa 2.8 To determine lattice parameter

```

1 clc();
2 clear;
3 //To determine the lattice parameter
4 //free volume=a^3-[2*(4/3)*pi*r^3]
5 //for bcc a=4r/3^(1/3)
6 fv=61.72*(10^-30);                     // free
    volume
7 a=-[fv/(1-%pi*sqrt(3))/8]^1/3*10^31    //
    lattice parameter
8 printf("The lattice parameter is %f A",a);

```

Scilab code Exa 2.9 Density of free electrons

```
1  clc();
2  clear;
3  //To determine the density of free electrons
4  rho=9000; //density in kg/m
    ^3
5  w=65; //atomic weight
6  v=1; //volume in m^3
7  n=(rho*v)/(w/(6.022*10^26)); //number of atoms
8  a=1.4; //average number
    of free electrons per atom
9  rhoe=n*a //density of free
    electrons per atom in electrons/m^3
10 printf("The density of free electrons is %e
    electrons/m^3",rhoe);
```

Scilab code Exa 2.10 To determine lattice parameter

```
1  clc();
2  clear;
3  //To determine the lattice parameter
4  h=1;
5  k=0;
6  l=1;
7  d101=0.5; //spacing of (101) plane
8  //d101=a/sqrt((h^2)+(k^2)+(l^2))
9  a=d101*sqrt(2) //lattice parameter
10 printf("The lattice parameter is %f A",a);
```

Chapter 4

Interference

Scilab code Exa 4.1 Wavelengths absent in reflected light

```
1  clc();
2  clear;
3  //To determine the wavelengths absent in the
   reflected light
4  i=40;                                //angle of
   incidence
5  mew=1.2;                              //refractive
   index
6  r=asind(sin(i)/mew);
7  t=0.23;                               //thickness
   of the film
8  lambda1=(2*mew*t*cosd(r))*10^3
9  lambda2=lambda1/2;
10 printf("The wavelength absent is %f nm",lambda1);
```

Scilab code Exa 4.2 To calculate thickness of air film

```
1  clc();
```

```

2 clear;
3 //To calculate the thickness of the air film
4 lambda1=400*10^-9;           //wavelength 1
5 lambda2=600*10^-9;         //wavelength 2
6 //2*t=n*lambda
7 n=150;                       //since 600*n=(n
    +75)400
8 t=((n*lambda2)/2)*10^6
9 printf("The thickness of the air film is %d micro
    meter",t);

```

Scilab code Exa 4.3 To calculate the bandwidth

```

1 clc();
2 clear;
3 //To calculate the bandwidth
4 lambda=600*10^-9;
5 mew=2;
6 teta=0.025;                 //wedge-
    angle
7 x=(lambda/(2*mew*sind(teta)))*10^2 //bandwidth
8 printf("The bandwidth is %f cm",x);

```

Scilab code Exa 4.4 Refractive index of liquid

```

1 clc();
2 clear;
3 //To calculate the refractive index of liquid
4 xair=0.15;                  //bandwidth of air
5 xliq=0.115;                //bandwidth of liquid
6 mewair=1;                   //refractive index of
    air

```

```

7 mewliq=(xair*mewair)/xliq      //refractive index of
   liquid
8 printf("The refractive index of liquid is %f",mewliq
   );

```

Scilab code Exa 4.5 Diameter of ninth dark ring

```

1 clc();
2 clear;
3 //To determine the diameter of the ninth dark ring
4 n=9;
5 lambda=589*10^-9;           //wavelength of
   light used
6 R=0.95;                     //radius of
   curvature of lens
7 mew=1;
8 D=(sqrt((4*n*lambda*R)/mew))*10^2 //diameter of
   the ninth dark ring
9 printf("The diameter of the ninth dark ring is %f cm
   ",D);

```

Scilab code Exa 4.6 Wavelength of light used

```

1 clc();
2 clear;
3 //To determine the wavelength of light used
4 x=0.055;                    //distance in fringe
   shift
5 n=200;                      //number of fringes
6 lambda=((2*x)/n)*10^6       //wavelength
7 printf("The wavelength of light used is %d nm",
   lambda);

```

Scilab code Exa 4.7 To determine thickness of the plate

```
1 clc();
2 clear;
3 //To determine the thickness of the plate
4 n=50; //number of
    fringes
5 lambda=500*10^-9; //wavelength of
    light used
6 mew=1.5; //refractive index
    of the plate
7 t=((n*lambda)/(2*(mew-1)))*10^6 //thickness of the
    plate
8 printf("The thickness of the plate is %d micro meter
    ",t);
```

Scilab code Exa 4.8 Minimum thickness of film

```
1 clc();
2 clear;
3 //To determine the minimum thickness of the plate
    for normal incidence of light
4 lambda=550*10^-9; //wavelength
5 mew=1.38; //refractive
    index
6 t=(lambda/(4*mew))*10^9 //thickness
7 printf("The minimum thickness of the plate for
    normal incidence of light is %f nm",t);
```

Scilab code Exa 4.9 Thickness of the film

```
1 clc();
2 clear;
3 //To determine the thickness of the film
4 i=35; //
   angle of incidence
5 mew=1.4; //
   refractive index
6 r=asind(sin(i)/mew);
7 //2*mew*cos(r)=n*lambda
8 n=50; //n
   (459)=(n+1)450
9 lambda=459*10-9;
10 t=(n*lambda/(2*mew*0.9122214))*106 //
   thickness of the film
11 printf("The thickness of the film is %f micro meters
   ",t);
```

Scilab code Exa 4.10 To calculate the wedge angle

```
1 clc();
2 clear;
3 //To calculate the wedge angle
4 lambda=500*10-9; //wavelength
5 x=0.07; //observed
   band width
6 mew=1; //refractive
   index
7 teta=(asind(lambda/(2*mew*x)))*104 //wedge
   angle
8 printf("The wedge angle is %f",teta);
```

Scilab code Exa 4.11 Refractive index of liquid

```
1 clc();
2 clear;
3 //To determine the refravtive index of liquid
4 dair=0.42; //diameter of certain
   rings
5 dliq=0.38; //diameter of rings
   when liquid is introduced
6 mew=dair^2/dliq^2 //refractive index of
   liquid
7 printf("The refravtive index of liquid is %f",mew);
```

Scilab code Exa 4.12 Wavelength of light used

```
1 clc();
2 clear;
3 //To determine the wavelength of light used
4 m=8; //
   eigth ring
5 n=3; //
   third ring
6 dm=0.4; //
   diameter of the eigth ring
7 dn=0.2; //
   diameter of the third ring
8 R=101; //
   Radius of curvature
9 lambda=(((dm^2)-(dn^2))/(4*R*(m-n)))*10^5 //
   wavelength of light
10 printf("The wavelength of light used is %fcm",lambda
   )
```

Scilab code Exa 4.13 Wavelength with high transmission

```
1 clc();
2 clear;
3 //To determine the wavelength which has high
  transmission
4 mew=1.38;           //refractiveindex of magnesium
  fluoride
5 t=175;             //thickness of coating of
  magnesium fluoride in nm
6 lambda=4*t*mew     //wavelength
7 printf("The wavelength which has high transmission
  is %f nm",lambda);
```

Chapter 5

Diffraction

Scilab code Exa 5.1 To determine the width of the slit

```
1 clc();
2 clear;
3 //To determine the width of the slit
4 n=1;
5 lambda=600*10^-9;           //wavelength
6 teta=35;                    //angle at which
   first minimum falls
7 d=((n*lambda)/sind(35))*10^6 //width of the
   slit
8 printf("The width of the slit is %f micro m",d);
```

Scilab code Exa 5.2 To determine central band

```
1 clc();
2 clear;
3 //To determine the width of a central band
4 D=0.95;                      //distance of the
   screen from the slit
```

```

5 lambda=589*10^-9;           //wavelength in m
6 d=0.5*10^-3;               //width of the slit
7 y=((2*D*lambda)/d)*10^3    //width of a
    central band
8 printf("The width of the central band is %f mm",y);

```

Scilab code Exa 5.3 To determine width of slit

```

1 clc();
2 clear;
3 //To determine the slit width
4 D=1.1;                       //distance of the
    screen from the slit
5 lambda=589*10^-9;           //wavelength in m
6 y=4.5*10^-3;                //distance of first
    minimum on either side of central maximum
7 d=((D*lambda)/y)*10^3       //slit width
8 printf("The slit width is %f mm",d);

```

Scilab code Exa 5.4 Distance between central maximum and fourth dark fringe

```

1 clc();
2 clear;
3 //To determine the distance between centres of
    central maximum and the fourth dark fringe
4 n=4;
5 lambda=589.6*10^-9;         //wavelength
6 D=0.95;                     //distance of
    the screen from the slit
7 w=0.28*10^-3;               //width of the
    slit
8 d=((n*lambda*D)/w)*10^3

```

```
9 printf("The distance between centres of central
    maximum and the fourth dark fringe is %f mm",d);
```

Scilab code Exa 5.5 Ratio of intensities of central and secondary maximum

```
1 clc();
2 clear;
3 //To calculate the ratio of intensities of central &
    second secondary maximum
4 s=5*%pi/2; //secondary
    maximum
5 I=(sin(s)/s)^2 //I2/I0
6 printf("Ratio of intensities of central & second
    secondary maximum is %f",I);
```

Scilab code Exa 5.6 Minimum number of lines per cm

```
1 clc();
2 clear;
3 //To calculate the minimum number of lines per cm
4 lambda=450*10^-9; //wavelength
5 n=2;
6 dlambda=1*10^-9; //difference in
    wavelength
7 N=lambda/(n*dlambda) //minimum number
    of lines per cm
8 printf("The minimum number of lines per cm is %d",N)
    ;
```

Scilab code Exa 5.7 Angle at which first minimum will be observed

```
1 clc();
2 clear;
3 //To calculate the angle at which first minimum will
  be observed
4 n=1;
5 lambda=650*10^-9; //wavelength
6 d=2*10^-6; //width of
  the slit
7 teta=asind((n*lambda)/d) //angle at
  which first minimum will be observed
8 printf("The angle at which first minimum will be
  observed is %f",teta);
```

Scilab code Exa 5.8 To determine width of the slit

```
1 clc();
2 clear;
3 //To determine the slit width
4 lambda=600*10^-9; //
  wavelength
5 y=2*10^-3; //width
  of the central band
6 D=1; //
  distance of the screen from the slit
7 d=((2*D*lambda)/y)*10^3 //slit
  width
8 printf("The slit width is %f mm",d);
```

Scilab code Exa 5.9 Wavelength of light used

```
1 clc();
```

```

2 clear;
3 //To determine the wavelength of light used
4 y=6*10^-3; //first minimum is
   observed
5 d=90*10^-6; //slit width
6 D=0.98; //distance of the
   screen from the slit
7 lambda=((y*d)/D)*10^9 // wavelength
8 printf("The wavelength of light used is %f nm",
   lambda);

```

Scilab code Exa 5.10 Wavelength of spectral line

```

1 clc();
2 clear;
3 //To calculate the wavelength of second spectral
   line
4 n=1;
5 lambda1=450*10^-7; //wavelength of
   first spectral line
6 d=1/5000;
7 teta1=asind((n*lambda1)/d);
8 teta2=teta1+2.97;
9 lambda2=((d*sind(teta2))/n)*10^7 //wavelength of
   second spectral line
10 printf("The wavelength of second spectral line is %f
   nm",lambda2);

```

Scilab code Exa 5.11 Minimum grating element required

```

1 clc();
2 clear;

```

```
3 //To determine the minimum grating element required
  to observe the entire third order spectrum
4 n=3;
5 lambda=700*10^-9;           //wavelength
6 teta=90;
7 d=((n*lambda)/sin(teta))*10^6 //grating element
8 printf("The minimum grating element required to
  observe the entire third order spectrum is %f m",
  d);
```

Chapter 6

Polarisation

Scilab code Exa 6.1 To determine angle of refraction

```
1 clc();
2 clear;
3 //To determine the angle of refraction
4 mew=1.63; //refractive index of the
   glass plate
5 //tan ip=mew
6 ip=atand(mew); //ip=polarising angle
7 //ip+r=90
8 r=90-ip //r=angle of refraction
9 printf("The angle of refraction is %f",r);
```

Scilab code Exa 6.2 Percentage of incident unpolarised light

```
1 clc();
2 clear;
3 //To determine the percentage of incident
   unpolarized light
4 //I=I0(cos^2(teta))
```

```

5 teta=50; //angle made between two
  principle planes
6 I=(cosd(50))^2; //incident unpolarized light
7 //percentage of incident unpolarised light is (I/I0)
  *100 where I0 is incident polarised light .
8 I=(cosd(50))^2*100 //percentage of incident
  unpolarized light
9 printf("The percentage of incident unpolarized light
  is %f ",I);

```

Scilab code Exa 6.3 Angle between planes

```

1 clc();
2 clear;
3 //To determine the angle between planes of
  transmission of analyser and polariser
4 //I=I0*cos^2(teta)
5 //cos^2(teta)=I/I0
6 a=0.08; //a=I/I0;where I=incident
  unpolarized light & I0=incident polarized light
7 teta=acosd(sqrt(a)) //angle between planes of
  transmission of analyser and polariser
8 printf("The angle between the planes of transmission
  of analyser & polariser is +(or)- %f",teta);

```

Scilab code Exa 6.4 Intensities of ordinary and extraordinary light

```

1 clc();
2 clear;
3 //To compare the intensities of ordinary &
  extraordinary light
4 //IE=A^2(cos^2(teta));IO=A^2(sin^2(teta))
5 //I0/IE=tan^2(teta)

```

```

6  teta=40;                                //angle made between
    incident beam & optic axis
7  a=tand(40)^2                             //I0/IE
8  printf(" I0/IE=%f" ,a);

```

Scilab code Exa 6.5 Thickness of quarter wave plate

```

1  clc();
2  clear;
3  //To determine the thickness of a quarter-wave plate
4  lambda=589;                             //
    wavelength of light in nm
5  mew0=1.54;                              //refractive
    index for ordinary wave
6  mewE=1.55;                              //refractive
    index for extraordinary wave
7  t=lambda/(4*(mewE-mew0))*10^-3          //thickness
    in micro meters
8  printf("The thickness of a quarter-wave plate is %f
    micro meters",t);

```

Scilab code Exa 6.6 To determine the refractive index

```

1  clc();
2  clear;
3  //To determine the refractive index of material
    surface
4  ip=52;                                  //angle of
    polarization
5  mew=tand(ip)                            //
    refractive index of the material surface
6  printf("The refractive index of the material surface
    is %f",mew);

```

Scilab code Exa 6.7 To calculate the refractive index

```
1 clc();
2 clear;
3 //To determine the refractive index of quartz
4 r=33; //angle of
    refraction
5 ip=90-r; //polarising
    angle
6 mew=tand(ip) //refractive index
    of quartz
7 printf("The refractive index of quartz is %f",mew);
```

Scilab code Exa 6.8 Angle made by the plane of vibration of the incident light with the optic axis

```
1 clc();
2 clear;
3 //To determine the angle made by plane of vibration
    of the incident light with optic axis
4 //IE=A^2*cos^2(teta);IO=A^2*sin^2(teta)
5 //I0/IE=tan^2(teta)=0.65
6 a=0.65; //ratio of
    intensities of ordinary & extraordinary light
7 teta=atand(sqrt(a)) //angle made by
    plane of vibration of the incident light with
    optic axis
8 printf("The angle made by the plane of vibration of
    incident light with the optic axis is %f",teta);
```

Scilab code Exa 6.9 Phase difference between O and E rays

```
1 clc();
2 clear;
3 //To determine the phase difference between between
  O &E rays
4 mew0=1.544;

  //refractive index of ordinary waves
5 mewE=1.553;

  //refractive index of extraordinary waves
6 lambda=550;

  //wavelength in nm
7 t=9;
8 delta=((2*180)/(lambda*(10^-9)))*(mewE-mew0)*t
  *(10^-6) //mewE>mew0
9 printf("The phase difference between O and E rays is
  %f degrees",delta);
```

Scilab code Exa 6.10 Wavelength of light incident on quartz plate

```
1 clc();
2 clear;
3 //To determine the wavelength of light incident on a
  quartz plate
4 delta=50;

  //phase difference
5 mewE=1.544;

  //refractive index of extraordinary waves
6 mew0=1.553;
```

```
    //refractive index of ordinary waves
7  t=8;

    //thickness in nm
8  lambda=((2*180)/delta)*(mew0-mewE)*t*10^-6*10^9
    //mew0>mewE
9  printf("The wavelength of light incident is %f nm",
    lambda);
```

Chapter 7

Motion of charged particle

Scilab code Exa 7.1 Kinetic energy and speed of electron

```
1 clc();
2 clear;
3 //To calculate the kinetic energy and speed of the
  electron
4 e=1.6*10^-19; //charge
  of the electron
5 V=18; //
  potential difference in kV
6 K=e*V*10^3 //Kinetic
  energy in J
7 m=9.1*10^-31; //mass of
  the electron
8 v=sqrt((2*e*V*10^3)/m)*10^-7 //speed of
  electron in m/s
9 printf("The kinetic energy of electron is %e J and
  speed of the electron is %f m/s",K,v);
```

Scilab code Exa 7.2 Vector displacement of electron

```

1  clc();
2  clear;
3  //To determine the vertical displacement of electron
4  m=9.1*10-31; //mass of
    electron
5  vx=4*106; //velocity
    along x-axis
6  E=1500; //electric
    field strength
7  l=0.07; //length in
    y-axis
8  q=1.6*10-19; //charge of
    electron
9  y=(-q*E*(l2))/(2*m*(vx2))*102 //vertical
    displacement of electron
10 printf("The vertical displacement of electron when
    it leaves the electric field is %f cm",y);

```

Scilab code Exa 7.3 Time required for the proton to reach maximum height

```

1  clc();
2  clear;
3  //To determine the time required for the proton to
    reach the maximum height in electric field
4  u=5*105; //velocity in m/s
5  m=1.67*10-27; //mass of proton
6  q=1.6*10-19;
7  E=500; //electric field
8  t=((u*m*sind(42))/(q*E))*106
9  printf("The time required for the proton to reach
    the maximum height in electric field is %f micro
    sec",t);

```

Scilab code Exa 7.4 Orbital speed of proton

```
1 clc();
2 clear;
3 //To determine the orbital speed of proton
4 m=1.67*10^-27; //mass of proton
5 q=1.6*10^-19;
6 B=0.36; //magnetic field in
   T
7 R=0.2; //radius in m
8 v=((q*B*R)/m)*10^-6 //orbital speed of
   proton
9 printf("The orbital speed of proton is %f m/s",v);
```

Scilab code Exa 7.5 Pitch of the helix

```
1 clc();
2 clear;
3 //To calculate the pitch of the helix and radius of
   trajectory
4 v=2*10^6; //speed in m/s
5 teta=30; //angle at which
   proton enters at the origin of coordinate system
6 B=0.3; //magnetic field in
   iT
7 vp=v*sind(teta); //v(perpendicular
   component)
8 vpa=v*cosd(teta); //v(parallel
   component)
9 m=1.67*10^-27; //mass of proton
10 q=1.6*10^-19;
11 p=(vpa*2*%pi*m)/(q*B) //pitch of the helix
   described by the proton
12 R=((m*vp)/(q*B))*10^2 //radius of the
   trajectory
```

```
13 printf("the pitch of the helix is %f m and radius of
    trajectory is %f cm",p,R)
```

Scilab code Exa 7.6 To calculate the displacement produced

```
1 clc();
2 clear;
3 //To determine the displacement produced ,the angle
    made by the beam with the axis ,velocity of
    electrons
4 V=25; //
    deflecting voltage
5 l=0.03; //
    length of deflecting planes in m
6 d=0.75; //
    distance between 2 deflecting plates
7 Va=800; //final
    anode voltage
8 D=0.2; //
    distance between the screen and the plates
9 y=((V*l)/(2*d*Va))*(D+(l/2))*10^4 //
    displacement produced
10 a=((V*l)/(2*d*Va))*10^2;
11 alpha=atand(a) //angle
    made by the beam with the axis
12 e=1.6*10^-19;
13 m=9.1*10^-31; //mass
    of electron
14 v=((sqrt((2*e*Va)/m))/cosd(alpha)) //
    velocity of electron
15 printf("the displacement produced is %f cm,the angle
    made by the beam with the axis is %f,velocity of
    electrons is %e m/s",y,alpha,v);
```

Scilab code Exa 7.7 Displacement of electron beam spot on the screen

```
1 clc();
2 clear;
3 //To determine the displacement of the electron beam
  spot on the screen
4 e=1.6*10^-19;
5 B=5*10^-5; //magnetic
  field in Wb/m^2
6 l=0.04; //length of
  magnetic field along the axis
7 m=9.1*10^-31; //mass of
  electron
8 D=0.25; //distance of
  the screen from the field
9 Va=600; //final anode
  voltage
10 y=(((e*B*l)/m)*sqrt(m/(2*e*Va))*(D+(l/2)))*10^2
11 printf("the displacement of the electron beam spot
  on the screen is %f cm",y);
```

Scilab code Exa 7.8 Separation on the photographic plate

```
1 clc();
2 clear;
3 //To calculate the separation on photographic plate
4 E=2.5*10^4; //electric
  field
5 B=0.18; //magnetic
  field
6 v=E/B; //velocity of
  particles
```

```

7 B1=0.22; //magnetic
   field in the main chamber
8 m2=13; //mass number
   of carbon
9 m1=12; //mass number
   of carbon
10 e=1.6*10^-9;
11 s=((2*v*(m2-m1)*1.67*10^-27)/(e*B1))*10^12
12 printf("the seperation on photographic plate is %f
   cm",s);

```

Scilab code Exa 7.9 Intensity of electric field

```

1 clc();
2 clear;
3 //To determine the intensity of electric field
4 v=5.6*10^6; //speed of the
   electron
5 m=9.1*10^-31; //mass of
   electron
6 e=1.6*10^-19;
7 s=0.03; //distance
   travelled
8 E=(m*(v)^2)/(2*e*s) //intensity of
   electric field
9 printf("The intensity of electric field is %f N/C",E
   );

```

Scilab code Exa 7.10 Charge to mass ratio of the particle

```

1 clc();
2 clear;
3 //To determine the charge to mass ratio

```

```

4 v=5*10^7;
5 B=0.4; //magnetic field
6 r=0.711*10^-3; //radius of the circle
7 Q=v/(B*r) //Q=q/m
8 printf("The charge to mass ratio is %e",Q);

```

Scilab code Exa 7.11 Magnetic field required to bend a beam

```

1 clc();
2 clear;
3 //To determine the magnetic field
4 m=9.1*10^-31; //mass of electron
5 v=3*10^7; //speed of
   electron
6 R=0.05; //radius of the
   circle
7 q=1.6*10^-19;
8 B=((m*v)/(q*R))*10^-9 // magnetic field
9 printf("The magnetic field to bend a beam is %f mT",
   B);

```

Scilab code Exa 7.12 To determine the magnetic field

```

1 clc();
2 clear;
3 //To determine the magnetic field
4 m=9.1*10^-31; //mass of electron
5 q=1.6*10^-19;
6 t=8*10^-9; //time in ns
7 B=(2*%pi*m*500)/(q*t) //magnetic field
8 printf("The magnetic field is %f T",B);

```

Scilab code Exa 7.13 To determine the magnetic field

```
1 clc();
2 clear;
3 //To determine the magnetic field
4 v=9.15*10^7; //cyclotron
   frequency of proton
5 m=1.67*10^-27; //mass of proton
6 q=1.6*10^-19;
7 B=(2*%pi*v*m)/q // magnetic field
8 printf("The magnetic field is %f T",B);
```

Chapter 8

Magnetic Materials and Spectroscopy

Scilab code Exa 8.1 To determine temperature

```
1 clc();
2 clear;
3 //calculating temperature when average thermal energy
  of an atom is equal to its magnetic energy.
4 //The given condition is  $(\mu_B) = 3/2(kT)$ 
5  $\mu_B = 0.9 \times 10^{-23}$ ; //magnetic dipole moment
6  $B = 0.72$ ; //magnetic field applied
  in T
7  $k = 1.38 \times 10^{-23}$ ;
8  $T = (2 * \mu_B * B) / (3 * k)$  //T=temperature in Kelvin
9 printf("The temperature at which the avg.thermal
  energy of an atom is equal to its magnetic energy
  is%f K",T);
```

Scilab code Exa 8.2 Magnetisation of paramagnetic salt

```

1  clc();
2  clear;
3
4  //Calculating the magnetisation of paramagnetic salt
5
6  //(C=mew0*M*T)/B.
7  //Therefore M=(C*B)/(mew0*T)
8  C=2*10^-3;           //C is curies constant
9  B=0.4;              //applied magnetic field T
10 mew0=4*%pi*10^-7;
11 T=300;              //temperature in kelvin
12 M=(C*B)/(mew0*T)   //M is magnetisation
13 printf("%f A/m",M);

```

Scilab code Exa 8.3 Zeeman shift in wave length

```

1  clc();
2  clear;
3
4  //To measure Zeeman shift in wave length
5
6  //Zeeman shift in frequency is delta V=eB/4*Pi*m.
7  //v=c/lambda and dv=-cB(lambda)^2=mod[(c*d*lambda)/
   lambda^2]
8  //Therefore delta lambda=(lambda^2*delta v)/c=eB(
   lambda^2)/4*pi*m*c
9  e=1.6*10^-19;
10 B=0.35;             //magnetic field
11 lambda=500*10^-9;   //wavelength in m
12 m=9.1*(10^-31);
13 c=3*(10^8)*10^-9;  //speed of light
14 deltalambda=(e*B*(lambda)^2)/(4*(%pi)*m*c)
15 printf("Zeeman shift in wave length is %f nm",
   deltalambda);

```

Scilab code Exa 8.4 To determine temperature

```
1 clc ();
2 clear;
3 //Determining temperature when magnetisation , curies
   constant , magnetic field are given
4
5 //T=(C*B)/(mew0*B)
6 C=2.1*10^-3;           //C is curie's constant
7 B=0.38;               //magnetic field
8 mew0=4*(%pi)*10^-7;  //molecular magnetic moment
9 M=2.15;               //magnetisation in A/m
10 T=(C*B)/(mew0*M)     //temperature in kelvin
11 printf("Temperature is %f K",T);
```

Scilab code Exa 8.5 Magnetisation of paramagnetic salt

```
1 clc ();
2 clear;
3
4 //To measure magnetisation of paramagnetic salt
5
6
7 //(M1*T1)=(M2*T2) . Therefore M2=(M1*T1)/T2
8 M1=2;                 //Initial magnetisation in A/m
9 T1=305;               //Initial temperature in K
10 T2=321;
11 M2=(M1*T1)/T2        //M2 is magnetisation at 321K
12 printf("Magnetisation at 321 K is %f A/m",M2);
```

Scilab code Exa 8.6 To calculate the magnetic field

```
1  clc();
2  clear;
3
4  //To calculate the magnetic field
5
6  mew0=4*(%pi)*10^-7;           //molecular magnetic
    moment
7  M=4;                          //magnetisation in A/m
8  T=310;                        //temperature in K
9  C=1.9*10^-3;                  //Curie's constant
10 B=(mew0*M*T)/C                //magnetic field in T
11 printf("Magnetic field is %f T",B);
```

Scilab code Exa 8.7 To calculate the magnetic field

```
1  clc();
2  clear;
3
4  //To calculate the magnetic field
5  //e/m is gyromagnetic ratio.
6  deltalambda=0.01*10^-9;       //
    Zeeman shift
7  c=3*10^8;                     //
    speed of light in vacuum in m/s
8  lambda=600*(10)^-9;          //
    wavelength in m
9  e=1.6*10^-19;
10 m=9.1*10^-31;
11 B=(deltalambda*4*(%pi)*m*c)/(e*(lambda)^2) //
    uniform magnetic field
12 printf("Magnetic field is %f T",B);
```

Scilab code Exa 8.8 To determine e m ratio

```
1  clc();
2  clear;
3  // To determine e/m ratio
4  //e/m=(deltalambda*4*pi*c)/(B*(lambda)^2)
5  deltalambda=0.01*10^-9; //
   Zeeman shift
6  c=3*(10^8); //
   speed of light in vacuum in m/s
7  B=0.78; //
   magnetic field
8  lambda=550*(10^-9); //
   wavelength in nm
9  Y=(deltalambda*4*(%pi)*3*(10^8))/(B*(lambda)^2) //e
   /m ratio
10 printf(" e/m =%e",Y);
```

Chapter 9

Quantum Theory

Scilab code Exa 9.1 Power radiated by the filament

```
1  clc();
2  clear;
3  //To calculate the power radiated by the filament
4  r=0.05; //radius of
   the wire in mm
5  l=4; //length of
   the wire in cm
6  A=2*%pi*r*l*10^-5; //in m^2
7  //According to Stephen-Boltzmann law R=e*s*(T^4)
8  //P=R*A
9  e=1;
10 T=3000; //
   temperature in K
11 s=5.6703*10^-8; //s is
   stepfan's constant
12 p=s*(T)^4*A*e
13 printf("The power radiated by the filament is %f W",
   p);
```

Scilab code Exa 9.2 To calculate the number of photons

```
1 clc();
2 clear;
3 //To calculate the number of photons that reach the
  surface of the earth per square cm per second
4 h=6.626*10^-34; //
  plancks constant
5 c=3*10^8; //
  speed of light
6 lambda=550; //
  wavelength in nm
7 E=(h*c)/(lambda*10^-9); //
  energy of photon in J
8 Es=0.1/E //
  number of photons per square cm per second
9 printf("The number of photons that reach the surface
  of the earth per square cm per second are %e ",
  Es);
```

Scilab code Exa 9.3 Maximum kinetic energy of photoelectron

```
1 clc();
2 clear;
3 //To determine the maximum kinetic energy of
  photoelectron
4 h=6.626*10^-34; //
  plancks constant
5 c=3*10^8; //
  speed of light
6 lambda=300*10^-9; //
  wavelength
7 E=(h*c)/lambda //energy
  of photon
8 phi=(2.2*1.6*(10^-19))-1.94;
```

```

9 Kmax=E-phi //maximum
   kinetic energy
10 printf("The maximum kinetic energy is %f eV",Kmax);

```

Scilab code Exa 9.4 To determine the potential difference

```

1 clc();
2 clear;
3 //To calculate the potential difference
4 h=6.626*10^-34; //plancks
   constant
5 c=3*10^8; //speed of
   light
6 lambda=175*10^-9; //
   wavelength of light
7 w=5; //work
   function of nickel
8 E=(h*c)/(lambda*1.6*10^-19); //Energy of
   200 nm photon
9 //From photoelectric equation E-w is the potential
   difference
10 p=E-w //potential
   difference required to stop the fastest electron
11 printf("The potential difference that should be
   applied to stop fastest photoelectron emitted by
   the surface is %f eV",p);

```

Scilab code Exa 9.5 Shortest wavelength of X rays

```

1 clc();
2 clear;
3 //To calculate the shortest wavelength of X-rays
   produced by the machine

```

```

4 h=6.626*10^-34; //
   plancks constant
5 c=3*10^8; //
   speed of light
6 e=1.6*10^-19;
7 V=50; //
   accelerating voltage in kV
8 lambdamin=((h*c)/(e*V*10^3) )*10^9
9 printf("The shortest wavelength of X-rays roduced by
   the machine is %f nm",lambdamin);

```

Scilab code Exa 9.6 To calculate wavelength of line

```

1 clc();
2 clear;
3 //To determine the wavelength
4 lambda1=0.708; //
   wavelength of a certain line in an X-ray spectrum
5 Z1=42; //atomic
   number
6 Z2=24;
7 a=1; //
   screening constant
8 lambda2=(lambda1*(Z1-a)^2)/((Z2-a)^2)
9 printf("The wavelength of same line in target of Z
   =24 is %f A",lambda2);

```

Scilab code Exa 9.7 Distance between atomic planes

```

1 clc();
2 clear;
3 //To calculate the distance between atomic planes
4 //From Bragg's law 2*d*sin(teta)=n*lambda

```

```

5 n=1;
6 lambda=0.32;           //wavelength in
   nm
7 teta=28;              //angle at which
   first order Bragg's reflection is observed
8 d=lambda/(2*sind(28))
9 printf("The distance between atomic planes is %f nm"
   ,d);

```

Scilab code Exa 9.8 Wavelength of X rays

```

1 clc();
2 clear;
3 //To calculate the wavelength of X-rays in the
   incident beam
4 h=6.626*10^-34;      //plancks
   constant
5 teta=50;
6 m=9.1*10^-31;      //mass of
   electron
7 c=3*10^8;          //speed of
   light
8 deltalambda=(h/(m*c))*(1-cosd(50))*10^12
9 lambdafin=2.5;     //wavelength
   of scattered X-rays
10 lambdainit=lambdafin-deltalambda
11 printf("The wavelength of X-rays in the incident
   beam is %f pm",lambdainit);

```

Scilab code Exa 9.9 To determine the power of laser

```

1 clc();
2 clear;

```



```

3 //To determine the power of the laser
4 h=6.626*10^-34; //plancks
   constant
5 c=3*10^8; //speed of
   light
6 lambda=500; //wavelength
   of laser
7 E=(h*c)/lambda; //Energy of
   500 nm photon
8 N=2.52*10^16; //number of
   photons in a 20ms pulse
9 p=((E*N)/(20*10^-3))*10^9
10 printf("The power of the laser is %f W",p);

```

Scilab code Exa 9.10 Work function of the surface

```

1 clc();
2 clear;
3 //To calculate the work function of the surface
4 h=6.626*10^-34; //plancks
   constant
5 c=3*10^8; //
   speed of light
6 lambda=350; //
   threshold wavelength
7 W=((h*c)/(lambda*10^-9*1.6*10^-19))*10^-34
   //work function of the surface
8 printf("The workfunction of the surface is %f eV",W)
   ;

```

Scilab code Exa 9.11 To calculate the accelerating voltage

```
1 clc();
2 clear;
3 //To calculate the accelerating voltage
4 h=6.626*10^-34; //plancks
   constant
5 c=3*10^8; //speed of
   light
6 e=1.6*10^-19;
7 lambdamin=0.02*10^-9; //minimum
   wavelength in nm
8 V=((h*c)/(lambdamin*e))*10^-3 //
   accelerating voltage
9 printf("The accelerating voltage needed to produce
   minimum wavelength of 0.02 nm is %f kV",V);
```

Scilab code Exa 9.12 Angle of second order Braggs reflections

```
1 clc();
2 clear;
3 //To determine the angle of second order bragg's
   reflections
4 //According to Bragg's eq.2*d*sin(teta)=n*lambda
5 n=2; //since second
   order Bragg's eq.
6 d=5; //since d=5(lambda
   )
7 lambda=1;
8 a=(n*lambda)/(2*5*lambda);
9 teta=asind(a) //angle of second
   order Braggs reflections
10 printf("The angle of second order Braggs reflection
   is %f",teta);
```

Scilab code Exa 9.13 Accelerating voltage applied

```
1  clc();
2  clear;
3  //To determine the accelerating voltage applied
4  h=6.626*10-34;           //plancks
   constant
5  c=3*108;                //speed of
   light
6  lambda=0.03;            //wavelength
   in nm
7  E=(h*c)/(lambda*10-9); //energy of
   photon
8  TE=((E*100)/80);        //Total
   energy.E=80% of TE in J
9  TE=TE/(16.0017*10-17) //
   Total energy in kV
10 printf("The electron must have been accelerated
    through a potential difference of %f kV",TE);
```

Chapter 10

Quantum Mechanics

Scilab code Exa 10.1 To calculate de Broglie wavelength

```
1 clc();
2 clear;
3 //To calculate the de Broglie wavelength
4 v=10^7; //speed of electron in
          m/s
5 h=6.626*10^-34; //plancks constant
6 m=9.1*10^-31; //mass of electron
7 lambda=h/(m*v) //de Broglie
               wavelength in m
8 printf("The de Broglie wavelength is %e",lambda);
```

Scilab code Exa 10.2 To determine the kinetic energy

```
1 clc();
2 clear;
3 //To determine the kinetic energy of proton &
  electron
4 h=6.626*10^-34; //plancks
                  constant
```

```

5 lambda=0.3;                                //de Broglie
   wavelength
6 p=h/(lambda*10^-9);                        //
   uncertainty in determining momentum in kg.m/s
7 //For electron
8 me=9.1*10^-31;                             //mass of
   electron
9 K1=p^2/(2*me);                             //kinetic
   energy of electron in J
10 //For proton
11 mp=1.672*10^-27;                          //mass of
   proton
12 K2=p^2/(2*mp)                             //kinetic
   energy of proton in J
13 printf("The kinetic energy of electron is %e J and
   kinetic energy of proton is %e J",K1,K2);

```

Scilab code Exa 10.3 To calculate the kinetic energy

```

1 clc();
2 clear;
3 //To determine the kinetic energy
4 //K=p^2/(lambda^2*2*m) where K is kinetic energy
5 h=6.626*10^-34;                             //plancks
   constant
6 lambda=10^-14;                              //de Broglie
   wavelength
7 m=9.1*10^-31;                              //mass of
   electron
8 K=(h^2/((lambda^2)*2*m*1.6*10^-19))*10^-9
9 printf("The kinetic energy is %f Gev",K);
10 //It is not possible to confine the electron to a
   nucleus.The experimental observations show that
   even electrons associated with unstable atoms
   never have energy more than a fraction of MeV

```

Scilab code Exa 10.4 Uncertainty in determining the position

```
1 clc();
2 clear;
3 //To determine the uncertainty in determining the
  position of this electron
4 m=9.1*10^-31; //mass of
  electron
5 v=6*10^3; //speed of
  electron
6 p=m*v; //uncertainty
  in momentum in kg.m/s
7 h=6.626*10^-34; //plancks
  constant
8 deltap=0.00005*p; //uncertainty
  in p is 0.00005 of p
9 deltax=(h/(4*pi*deltap))*10^3 //uncertainty
  in position
10 printf("The uncertainty in position is %f mm",
  deltax);
```

Scilab code Exa 10.5 First 2 energy levels of a particle

```
1 clc();
2 clear;
3 //To determine the first two energy levels using
  particle-in-a-box model
4 L=3*10^-5; //
  diameter of the sphere
```

```

5 h=6.626*10^-34;
                                     //plancks
   constant
6 m=1.67*10^-27;
                                     //mass of
   the particle
7 n=1;
8 E1=((h^2)*(n^2))/(8*m*(L^2)*1.6*10^-19)*10^12
   //first energy level
9 E2=E1*2^2
                                     //
   second energy level
10 printf("The first energy level is %f Mev",E1);
11 printf("The second energy level is %f Mev",E2);

```

Scilab code Exa 10.6 Ground state and first excited state energy

```

1 clc();
2 clear;
3 //To determine ground state & first excited state
   energy
4 h=6.626*10^-34;
   constant
   //plancks
5 a=2*10^12;
   //angular
   frequency in rad/s
6 E0=(0.5*(h/(2*pi*1.6*10^-19))*a)*10^3
   //ground
   state energy
7 E1=(1.5*(h/(2*pi*1.6*10^-19))*a)*10^3
   //first
   excited state energy
8 printf("The ground state energy is %f Mev and first
   excited state energy is %f Mev",E0,E1);

```

Scilab code Exa 10.7 To determine kinetic energy of electron

```

1  clc();
2  clear;
3  //To determine the kinetic energy of electron
4  h=6.626*10^-34;                                //plancks
        constant
5  E=85;                                          //Energy
        in keV
6  c=3*10^8;                                    //speed of
        light
7  lambda=(h*c)/(E*10^3*(1.6*10^-19));          //de
        Broglie wavelength
8  m=9.1*10^-31;                                //mass of
        electron
9  K=((h^2)/((lambda^2)*2*m*1.6*10^-9))*10^7    //kinetic
        energy of electron
10 printf("The kinetic enery of the electron is %f keV"
        ,K);

```

Scilab code Exa 10.8 To determine velocity of electron

```

1  clc();
2  clear;
3  //To determine velocity of an electron
4  lambda=0.08;
        //de Briglie wavelength
5  m=9.1*10^-31;
        //mass of electron
6  h=6.626*10^-34;                                //
        plancks constant
7  v=h/(m*lambda*10^-9)                          //
        velocity of the electron
8  printf("The velocity of the electron is %f m/s",v);

```

Scilab code Exa 10.9 To determine the potential difference

```
1 clc();
2 clear;
3 //To determine the potential difference
4 h=6.626*10^-34; //plancks
   constant
5 lambda=589*10^-9; //wavelength in m
6 m=9.1*10^-31; //mass of
   electron
7 e=1.6*10^-19;
8 V=((h^2)/((lambda^2)*2*m*e))*10^6 //potential
   difference
9 printf("The potential difference through which an
   electron should be accelerated to have a
   wavelength of 589 nm is %f microV ",V);
```

Scilab code Exa 10.10 Uncertainty in velocity of electron

```
1 clc();
2 clear;
3 //To determine uncertainty in velocity
4 deltax=0.92*10^-9; //
   uncertainty in position
5 m=9.1*10^-31; //mass of
   electron
6 h=6.626*10^-34; //plancks
   constant
7 deltav=h/(4*%pi*m*deltax) //
   uncertainty in velocity
8 printf("The uncertainty in velocity is %f m/s",
   deltav);
```

Scilab code Exa 10.11 Length of the box for a proton

```
1 clc();
2 clear;
3 //To determine the length of a box
4 h=6.626*10^-34; //
   plancks constant
5 n=3; //
   for second excited state
6 m=1.67*10^-27; //
   mass of proton
7 E=0.5; //
   energy in Mev
8 L=((h*n)/sqrt(8*m*E*10^6*1.6*10^-19))*10^15 //
   length of the box
9 printf("The length of the box for proton in its
   second excited state is %f fm ",L);
```

Chapter 11

Nuclear Radiations and Detectors

Scilab code Exa 11.1 To calculate the radius of Li

```
1 clc();
2 clear;
3 //To calculate the radius of Li(mass no.7)
4 r0=1.2;           //in fm
5 A=7;             //mass number
6 //r=r0*(A)^1/3
7 r=r0*(A)^(1/3)
8 printf("The radius of Li with mass number 7 is %f fm
   ",r);
```

Scilab code Exa 11.2 Binding energy per nucleon

```
1 clc();
2 clear;
3 //To determine the binding energy per nucleon of U
   with mass no. 235
```

```

4 M=235.043945;           //atomic mass of uranium
5 Z=92;                   //atomic number of uranium
6 mp=1.007825;           //mass
   of proton
7 N=143;                   //no. of
   neutrons
8 mn=1.008665;           //mass
   of neutron
9 A=235;                   //number
   of nucleons
10 B=[[(Z*mp)+(N*mn)-(M)]/A]*931.5 //Binding
    energy in MeV
11 printf("The binding energy per nucleon is %f MeV",B)
    ;

```

Scilab code Exa 11.3 minimum energy required to remove a neutron from nucleus

```

1 clc();
2 clear;
3 //To calculate the minimum energy required to remove
   a neutron from Ca(A=43;Z=20)
4 //After removing one neutron from Ca(A=43;Z=20) it
   becomes Ca(A=42;Z=20)
5 M=41.958622;           //mass of Ca(A=42;Z=20)
6 mn=1.008665;           //mass of neutrom
7 C=M+mn;
8 E=42.95877;           //mass of Ca(A=43;Z=20)
9 D=C-E;
10 B=D*931.5             //Binding energy of
    neutron
11 printf("The binding energy of neutron is %f MeV",B);

```

Scilab code Exa 11.4 To determine the Q value of the reaction

```
1 clc ();
2 clear;
3 //To determine the Q-value
4 mBe=9.012182;           //Atomic mass of
   beryllium in u
5 mHe=4.002603;         //Atomic mass of helium
6 mn=1.008665;         //mass of neutron
7 mC=12.000000;        //Atomic mass of carbon
8 Q=(mBe+mHe-mn-mC)*931.5 //Q is called energy
   balance of the reaction
9 printf("The Q-value is %f MeV",Q);
```

Scilab code Exa 11.5 Q value of the reaction and energy of each alpha particle

```
1 clc ();
2 clear;
3 //To determine the Q-value
4 mLi=7.016004;         //mass of Lithium(A=7)
5 mH=1.007825;         //mass of Hydrogen(A=1)
6 mHe=4.002603;        //mass of helium(A=4)
7 Q=[mLi+mH-2*(mHe)]*931.5 //Q is the energy
   balance of the reaction
8 p=0.5;               //energy of proton in
   MeV
9 //The energy of 2 alpha particles is equal to the Q-
   value + energy of proton.
10 Ealpha=(Q+p)/2      //energy of each alpha
   particle
11 printf("The Q-value of the reaction is %f MeV and
   energy of each alpha particle is %f MeV",Q,Ealpha
   )
```

Scilab code Exa 11.6 To calculate the energy released

```
1 clc();
2 clear;
3 //To determine the amount of energy released
4 wt=1000; //weight in gm
5 A=235; //mass number of
   uranium
6 N=[6.02*(10^23)/A]*wt; //no. of nuclei in
   1kg of uranium
7 Q=208; //energy-balance
   of the reaction
8 E=N*Q; //Energy released
   in MeV
9 //1MeV=4.45*10^-20kWh
10 E=E*4.45*(10^-20)
11 printf("The energy released is %f kWh",E);
```

Scilab code Exa 11.7 power output of a nuclear reactor

```
1 clc();
2 clear;
3 //To determine the power output of a nuclear reactor
4 wt=5000; //weight in gm
5 A=235; //mass number of
   uranium
6 N=(6.02*(10^23)/A)*wt; //number of nuclei
   in 5 Kg
7 Ef=208; //Energy released
   per fission in MeV
8 E=N*Ef; //Energy in MeV
9 E=E*1.6*(10^-13); //Energy in J
```

```

10 T=24*60*60; //time
11 P=E/T //power
12 printf("The power output of a nuclear reactor is %f
    MW",P);

```

Scilab code Exa 11.8 Amount of U required

```

1 clc();
2 clear;
3 //To calculate the amount of Uranium(A=235) required
4 A=235; //mass number of
    uranium
5 p=1000; //amount of
    electric power produced
6 e=0.32; //energy
    conversion efficiency of the plant
7 I=p/e; //Input nuclear
    energy in MW
8 f=200; //fission energy
    per event in MeV
9 TE=I*(10^6)*3600*24*365; //total energy in
    J
10 EF=f*(10^6)*1.6*(10^-19); //Energy released
    per fission event in J
11 N=TE/EF; //Number of
    nuclei required
12 M=(N*A)/[6.02*(10^23)]*10^-3 //corresponding
    mass in kg
13 printf("The amount of uranium required is %f kg",M);

```

Scilab code Exa 11.9 Frequency of oscillator to be used

```

1 clc();

```

```

2 clear;
3 //To determine the frequency of oscillator to be
  used to accelerate protons
4 q=1.6*(10*10^-19);           //charge of the
  particle
5 B=1;                         //magnetic field
  in T
6 m=1.67*(10^-27);           //mass of proton
  in kg
7 omega=(q*B)/m;             //angular
  frequency in radians/s
8 v=[omega/(2*pi)]*10^-8;    //in MHz
9 r=0.5;                       //radius in m
10 s=omega*r;                 //speed of
  proton in m/s
11 K=[m*(s^2)]*(1/2)*6.27*10^10 //kinetic energy
  of protons emerging from cyclotron
12 printf("The frequency of oscillator to accelerate
  protons is %f radians/s ,speed of proton is %f m/
  s and the kinetic energy of protons emerging from
  the cyclotron is %f MeV",omega,s,K);

```

Scilab code Exa 11.10 To calculate the radius

```

1 clc();
2 clear;
3 //To calculate radius
4 rho=1.83*(10^17);           //average
  density of carbon nucleus in kg/m^3
5 m=12;                       //mass in u
6 //rho=m/[(4/3)*pi*r]. Therefore r=[m/[(4/3)*pi*rho]
  ]^(1/3)

```



```

7 r=[m*1.66*(10^-27)/((4/3)*%pi*rho)]^(1/3)*10^15
    //radius in fm
8 printf("The radius is %f fm",r);

```

Scilab code Exa 11.11 To calculate the cyclotron frequency

```

1 clc();
2 clear;
3 //To calculate cyclotron frequency of of electron
4 q=1.6*(10^-19); //charge of the
    particle
5 B=5; //magnetic field in
    T
6 m=9.1*(10^-31); //mass of electron
    in kg
7 v=(q*B)/(2*%pi*m) //cyclotron
    frequency in Hz
8 printf("cyclotron frequency of of electron is %e Hz"
    ,v);

```

Scilab code Exa 11.12 To determine the magnetic field

```

1 clc();
2 clear;
3 //To determine the magnetic field
4 k=1.5;
    //maximum kinetic energy in MeV
5 m=1.67*10^-27; //
    mass of proton in kg
6 q=1.6*(10^-19); //
    charge of particle
7 r=0.35; //
    radius in m

```

```

8 //k=[(q^2)*(B^2)*(r^2)]/(2*m). Therefore B=[sqrt(k*2*
    m)]/q*r
9 B=sqrt(k*10^6*1.6*10^-19*2*m)/(q*r) //
    magnetic field in T
10 printf("The magnetic field is %f T",B);

```

Scilab code Exa 11.13 To determine the magnetic field

```

1 clc();
2 clear;
3 //To calculate magnetic field
4 m=1.67*(10^-27);
    //mass of proton
5 q=1.6*10^-19;
    //charge of particle
6 v=25;
    //cyclotron frequency in MHz
7 //v=(q*B)/(2*pi*m). Therefore B=(v*2*pi*m)/q
8 B=(v*10^6*2*pi*m)/q
9 printf("The required magnetic field is %f T",B);

```

Scilab code Exa 11.14 Charge to mass ratio for proton

```

1 clc();
2 clear;
3 //To determine the charge to mass ratio for proton
4 v=20; //cyclotron
    frequency in MHz
5 B=1.3; //magnetic field in
    T
6 //d=q/m=(2*pi*v)/B
7 d=(2*pi*v*10^6)/B //charge to mass
    ratio of proton

```

```
8 printf("q/m=%f C/kg", d);
```

Chapter 13

Optical Fibre

Scilab code Exa 13.1 Numerical aperture of a fibre

```
1 clc();
2 clear;
3 //To calculate the numerical aperture
4 n1=1.49; //refractive index of
   core
5 n2=1.46; //refractive index of
   cladding
6 //NA=sqrt((n1^2)-(n2^2))
7 NA=sqrt((n1^2)-(n2^2)) //Numerical aperture
8 printf("The numerical aperture is %f",NA);
```

Scilab code Exa 13.2 To determine the acceptance angle

```
1 clc();
2 clear;
3 //To determine acceptance angle
4 NA=0.5; //numerical
   aperture of fibre
```

```

5 n0=1; //refractive
    index of the medium (air) from which ray enters
    the fibre
6 //NA=n0*sin(i) where i is the acceptance angle.
7 i=asind(NA/n0) //acceptance
    angle in degrees
8 printf("The acceptance angle is %d degrees",i);

```

Scilab code Exa 13.3 Number of guided modes

```

1 clc();
2 clear;
3 //To determine the number of guided modes
4 NA=0.25; //numerical
    apperture
5 lambda=0.75; //wavelength in
    micro metres
6 a=25; //core radius i.e
    50/2=25
7 f=(2*pi*a*NA)/lambda; //normalised
    frequency
8 Ng=(f^2)/2 //number of
    guided modes
9 printf("The number of guided modes is %f",Ng);

```

Scilab code Exa 13.4 Signal attenuation per kilometer

```

1 clc();
2 clear;
3 //To determine the signal attenuation per kilometer
4 pi=100; //mean optical
    power launched in micro meter

```

```

5 po=5;                                //mean optical
   power at fibre output
6 S=10*log10(pi/po);                    //signal
   attenuation un dB
7 l=6;                                  //length in km
8 Sk=S/l                                //signal
   ayyenuation per kilometer
9 printf("The signal attenuation per kilometer is %f
   dB/km",Sk);

```

Scilab code Exa 13.5 Numerical aperture for the optical fibre

```

1 clc();
2 clear;
3 //To determine the numerical aperture
4 ns=2.89;                               //sum of
   refractive indices of core & cladding
5 nd=0.03;                               //difference of
   refractive indices of core & cladding
6 NA=sqrt(ns*nd)                          //numerical
   apperture
7 printf("The numerical apperture for the optical
   fibre is %f",NA);

```

Scilab code Exa 13.6 Number of guided modes

```

1 clc();
2 clear;
3 //To determine the number of guided modes
4 NA=0.28;                                //
   numerical aperture
5 a=30;                                    //core
   radius

```

```

6 lambda=0.8; //
   wavelength in micro meter
7 f=(2*pi*a*NA)/lambda; //
   normalised frequency
8 Ng=f^2/2 //number of
   guided modes
9 printf("The number of guided modes is %f",Ng);

```

Scilab code Exa 13.7 To determine the mean optical power

```

1 clc();
2 clear;
3 //To calculate the mean optical power launched into
   a fibre
4 S=2; //signal attenuation per km
5 l=1; //length in km. Since l=1 S=2
6 //S=10*log(pi/p0) (or) pi/p0=10^(S/10)
7 p0=20; //mean optical power at
   fibre output
8 pi=p0*10^(S/10) //mean optical power
   launched into fibre
9 printf("The mean optical power launched into a fibre
   of length of 1km is %f micri W",pi);

```

Scilab code Exa 13.8 To determine the mean optical power

```

1 clc();
2 clear;
3 //To determine pi/p0
4 S=2.3; //Signal attenuation per
   km
5 l=4; //length in km

```

```

6 S=S*1; //signal attenuation for 4
   km in dB
7 //S=10*log(pi/po)(or) pi/po=10^(S/10)
8 P=10^(S/10) //mean optical power
   launched into fibre(pi)/mean optical power at
   fibre output (po)
9 printf(" pi/po=%f" ,P);

```

Scilab code Exa 13.9 To calculate signal attenuation

```

1 clc();
2 clear;
3 //To determine signal attenuation
4 //given condition:po=pi/4 where p0=mean optical power
   at fibre output ,pi=mean optical power launched
   into fibre
5 //S=10*log(pi/po)
6 S=10*log10(1/(1/4)) //signal attenuation in
   dB
7 printf(" Signal attenuation when po=pi/4 is %f dB" ,S)
   ;

```
