Scilab Textbook Companion for Physics For Engineers by M. R. Srinivasan[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

Vibrations and Resonance

Scilab code Exa 1.1 Damped Oscillations

```
clc ;
clear ;
m=100*10^-3 //flat disc mass in kg
t=60 //time period of oscillation in sec
omega=10 //frequency in Hz

//Calculation
damp_omega=log(2)/60 //amplitude of damped oscillator for A/C = 1/2 in rad/s
c= 2*m*damp_omega
tau= 1/damp_omega

mprintf("Resistive force = %0.2e newton-s/meter \n",c)
mprintf("Relaxation time = %2.2f s",tau) //The answer provided in the textbook is wrong.
```

Scilab code Exa 1.2 Damped Oscillations

```
clc ;
clear ;
K=10 //Spring constant in N/m
m=0.1 //Mass in kg

//calculation
// for (a)
damp_omega=-1/-100
c=m*2*damp_omega

//for (b)
omega_n=sqrt(K/m)

//for (c)
eta=damp_omega/omega_n
Q=1/(2*eta)
omega_d=omega_n*sqrt(1-eta^2) //in radian/s

//for (d)
fract_change=0.5*(eta^2) //fractional change in
    frequency
percent_change=fract_change*(10^2)

mprintf("\n(a)\n")
mprintf("Resistive force constant c = %.0e newton-s/
    meter\n",c)
mprintf("(b)\n")
mprintf("Natural angular frequency omega_n = %d rad/
    s\n",omega_n)
mprintf("(c)\n")
```

```
mprintf("Damping ratio eta = %.0e\n",eta)
mprintf("Q factor = %d\n",Q)
mprintf("(d)\n")
mprintf("percent change in frequency = %.0e\n",percent_change)
```

Scilab code Exa 1.3 Harmonic oscillations

```
clc ;
clear ;
m=0.1 // mass in kg
K=100 //spring constant in N/m
c=1 //resistive force in Nsm^-1
F0=2 //force in N
omega=50 //frequency in rad/s

//calculation

omega_n=sqrt(K/m) //in rad/s
r=omega/omega_n
delta_st=F0/K //in m
damp_ratio=c/(2*m*omega_n)
A=delta_st/(sqrt((1-r^2)^2+(2*r*damp_ratio)^2))
tan_phi=(2*r*damp_ratio)/(1-r^2) //in degree
phi=180+atand(tan_phi) //converting degree to postive form

mprintf("Amplitude of oscillation = %1.2e m\n",A)
mprintf("Phase relative to the applied force is = %1.1f degree",phi)
//The answers vary due to round of errors
```

Scilab code Exa 1.4 Series circuit

```
clc;
clear;
omega=500 //frequency in radian/s
L=0.08 //inductance in H
R=15 //resistance in ohm
C=30*10^-6 //capacity in F

//calculation

L_omega=L*omega //in ohm
C_omega=1/(C*omega) //in ohm
tan_phi=(L_omega-C_omega)/R //in degrees
phi=atand(tan_phi)

mprintf("The current leads the applied voltage by =
    %2.2f degree",-phi)
//The answers vary due to round off error
```

Scilab code Exa 1.5 Series circuit

```
clc;
clear;
phi=45 //since the EMF is ahead of the current by
    55-10 in degree
omega=3000 //frequency in radian/s
L=0.01 //inductance in H
```

```
E0=141.4 //electric field in V
I0=5 //current in A

//calculation
Z1=sqrt(2) //first equation for impedence Z
Z2=E0/I0//second equation for impedence Z
R=Z2/Z1 //resistance in ohm
L_omega=L*omega //in ohm
C=(1/((L_omega-R)*omega)/10^-6) //converting from F to micro F dividing by 10^-6


mprintf("Resistance is = %d ohm\n",R) //The answers vary due to round off error
mprintf("Capacitance is = %2.1f micro F\n",C)
```

Scilab code Exa 1.6 Series RLC circuit

```
clc;
clear;
R=50 //resistance in ohm
C=25 //capacitance in micro-F
L=0.15 //inductance in H
V=230 //voltage in Volts
f=50 //frequency in Hz

//calculation
XL=2*%pi*f*L //in ohm
XC=(10^6)/(2*%pi*f*C) //in ohm
X=XL-XC //in ohm
Z=sqrt(R^2+X^2)
I=V/Z
pf=R/Z
```

```
power_consumed=V*I*pf

mprintf("(i)Impedance = %2.1f ohm\n",Z) //The answers vary due to round off error
mprintf("(ii)Current = %1.2f A\n",I) //The answers vary due to round off error
mprintf("(iii)Power Factor = %1.2f (Lead)\n",pf)
mprintf("(iv)Power Consumed = %d W",power_consumed) //The answers vary due to round off error
```

Scilab code Exa 1.7 Insulated wire

```
clc;
clear;
R=8 //resistance in ohm
L=0.03 //inductance in H
V=240 //voltage in Volts
f=50 //frequency in Hz
reactance_RLC=9.42 //reactance of total RLC circuit in ohm in case(2)

//calculation
//for (1)
X_L=2*%pi*f*L // inductive reactance in ohm
Z=sqrt(R^2+X_L^2) //in ohm
I=V/Z // current in A
P=I^2*R // Power in Watt
pf=R/Z //power factor is the ratio of R/Z

//for (2)
reactance_C=2*reactance_RLC //capacitive reactance in ohm
omega=2*%pi*f //angular freqency in rad/s
```

```
C=(1/(omega*reactance_C)/10^-6) //converting from F to micro F dividing by 10^-6

mprintf("(i)Impedance = %2.1f ohm\n",Z) //The answer varies due to round off error
mprintf("(ii)Current = %1.2f A\n",I) //The answers varies due to round off error
mprintf("(iii)Power Factor = %1.2f (lag)\n",pf)
mprintf("(iv)Power Consumed = %d W\n",P) //The provided in the textbook is wrong.
mprintf("(v)The value of capacitance is = %d micro F \n",C)//The answers varies due to round off error
```

Scilab code Exa 1.8 Resonant circuit

```
clc;
clear;
C= 4*10^-6 // capacitance in F
L=0.25 // inductance in H
R=50 //resistance in ohm

//calculation

F0=1/(2*%pi)*sqrt(1/(L*C)-(R^2/L^2))

mprintf("The frequency of resonance = %f Hz",F0)
//The answer varies due to round off error
```

Scilab code Exa 1.9 Insulated wire

```
clc;
clear;
R=30 // resistance in ohm
L= 20*10^-3 //inductance in H
f=1000/%pi //frequency in Hz
V=25 //in volt

//calculation
// for (a)
inductance_l=2*%pi*f*L //in ohm
Z=sqrt(R^2+inductance_l^2) //in ohm
C=L/Z^2

mprintf("\n(a) The capacitance of the circuit is %d
   microF\n",C/10^-6) //converting from F to mF
   dividing by 10^-6

//for(b)

dynamic_imp=L/(C*R) //in ohm
I_min=V/dynamic_imp

mprintf("\n(b) The value of current is = %0.1f A",
   I_min)
```

Chapter 2

Acoustics of Buildings

Scilab code Exa 2.1 Absorption of cinema hall

```
clc;
clear;
V=7500 //volume in m^3
T=1.2 //time in seconds

//calculations
A=(0.162*V)/T

mprintf("Total absorption in hall = %0.1f sq-m
   sabine",A)
```

Scilab code Exa 2.2 Reverberation time of a hall

```
clc;
clear;
```

```
V=1500 //volume of hall in m^3
Area_plastered_wall=112 //in m^2
Area_woodem_floor=130 //in m^2
Area_plastered_ceiling=170 //in m^2
Area_wooden_doors=20 //in m^2
Area_cushioned_chairs=120 //in m^2
Area_Audience=120 //in m^2


//Coefficient of Absorption (c)
c_plastered_wall=0.03
c_woodem_floor=0.06
c_plastered_ceiling=0.04
c_wooden_doors=0.06
c_cushioned_chairs=0.50
c_Audience=0.4367



//calculation
Abs_plastered_wall=Area_plastered_wall*c_plastered_wall //in m^2 sabine
Abs_wooden_floor=Area_woodem_floor*c_woodem_floor //in m^2 sabine
Abs_plastered_ceiling=Area_plastered_ceiling*c_plastered_ceiling //in m^2 sabine
Abs_wooden_doors=Area_wooden_doors*c_wooden_doors //in m^2 sabine
Abs_cushioned_chairs=Area_cushioned_chairs*c_cushioned_chairs //in m^2 sabine
Total_absorption1 = Abs_plastered_wall+Abs_wooden_floor+Abs_plastered_ceiling+Abs_wooden_doors+Abs_cushioned_chairs //in m^2 sabine

//Case (i)
T1=(0.162*V)/Total_absorption1

```

```
//case (ii)
Abs_Audience=Area_Audience*c_Audience //in m^2 sabine when hall at full capacity
Total_absorption2 = Abs_plastered_wall+Abs_wooden_floor+Abs_plastered_ceiling+Abs_wooden_doors+Abs_cushioned_chairs+Abs_Audience //in m^2 sabine
T2=(0.162*V)/Total_absorption2

mprintf("Reverbertion time when hall empty = %1.2f s\n",T1)
mprintf("Reverbertion time when hall at full capacity = %1.2f s",T2) //The answer provided in the textbook is wrong
```

Scilab code Exa 2.3 Reverberation time

```
clc;
clear;
l=20 //room length in m
b=15 //room breadth in m
h=8 //room height in m
capacity=200 //number of seats in hall
Absorption_air=0.012 // per m^3

//Coefficient of Absorption (c)
c_wall=0.09
c_ceiling=0.04
c_floor=0.06 //Value given in the sum is wrong which is 0.60
c_seat=0.64


```

```
//calculation
A1=2*((b*h)+(l*h))*c_wall //in m^2
A2=(l*b)*c_ceiling //in m^2
A3=(l*b)*c_floor //in m^2
A4=(capacity/2)*(1-c_seat) //in m^2
A5=(capacity/2)*(c_seat) //in m^2
Volume=l*b*h //in m^3
A6=Volume*Absorption_air
T=A1+A2+A3+A4+A5+A6 //Total absorptionin m^2
T=0.161*(Volume/(T+A6))

mprintf("Reverberation time = %1.2f s",T) //The
    answer provided in the textbook is wrong.
```

Chapter 4

Interference

Scilab code Exa 4.1 Double slit experiment

```
clc;
clear;
d=0.08*10^-2 //distance between parallel slits in m
Beta=6*10^-4 //fringe width in m
v=8*10^11*10^3 //frequency of light in Hz
c=3*10^8 //velocity of light in m/s

//calculation
lambda=c/v //wavelength in m
D=(Beta*d)/lambda

mprintf("The distance of the screen from the slits
   should be = %1.2f m",D)
```

Scilab code Exa 4.2 Youngs double slit experiment

```
clc;
clear;
lambda_1=4200*10^-10 //wavelength in m in first case
Beta_1=0.46*10^-2 //fringe width in m in first case
Beta_2=0.64*10^-2 //fringe width in m in second case

//calculation
lambda_2=(lambda_1*2*Beta_1)/Beta_2 //dividing first
    case by second
mprintf("The wavelength of the light source to
   obtain fringes %1.2e m wide is = %4.1f A",Beta_1,
   lambda_2*10^10) //multiplying by 10^10 to convert
    into Angstrom
```

Scilab code Exa 4.3 Fresnels biprism

```
clc;
clear;
D=0.82 //distance between the source and the screen
   in m
B=0.02 //distance between the source and the biprism
    in m
lambda=6900*10^-10 //wavelength in m
myu=1.5 //refractive index
alpha=%pi/180 //refracting angle in radian

//calculation
d=2*(myu-1)*alpha*B //distance between sources in m
Beta=(lambda*D)/d

mprintf("The fringe width is = %1.3e m",Beta)
```

Scilab code Exa 4.4 Fresnels biprism

```
clc;
clear;
D=1 //distance between the source and the screen in
    m
lambda=5893*10^-10 //wavelength in m
d1=4.05*10^-3 //distance between two images of the
    slit in m in first case
d2=2.90*10^-3 //distance between two images of the
    slit in m in second case

//calculation
d=sqrt(d1*d2) //distance between the slits in m
Beta=(lambda*D)/d

mprintf("The distance between interference fringes
    is %1.2e m",Beta)
//The answer provided in the textbook is wrong.
```

Scilab code Exa 4.5 Biprism experiment

```
clc;
clear;
I=0.7*10^-2 //size of the image in m
u=0.3 //distance between the convex lens and the
    slit in m
v=0.7 //distance between the images in m
```

```
D=1 // distance between the slit and the images in m
Beta=0.0195*10^-2 //fringe width in m

//calculation
d=(I*u)/v
lambda=(Beta*d)/D

mprintf("The wavelength of light used is = %e m or
   5850*10^-10 m.",lambda)
```

Scilab code Exa 4.6 Youngs double slit experiment

```
clc;
clear;
Y1=1*10^-3 //distance of the point from the screen
   in m for first case
D=1 //distance between the slit and the screen in m
d=1*10^-3 //distance between the slits in m
lambda=5893*10^-10 //wavelength in m
phase_diff2=%pi/2 //phase difference when intensity
   is half the maximum

//calculation
delta_1=(Y1*d)/D //path difference in  m
phase_diff=(2*%pi*delta_1)/lambda //phase difference
    in radian
Ratio=cos(phase_diff/2)^2
mprintf("\nThe ratio of intensity with the central
   maximum is = %1.4f\n",Ratio)
//The answer provided in the textbook is wrong.

delta_2=(phase_diff2*lambda)/2*%pi
Y2=(delta_2*D)/d
```

```
mprintf("The distance of the point on the screen from the centre is %1.3e m",Y2)
//The answer provided in the textbook is wrong.
```

Scilab code Exa 4.7 Biprism experiment

```
clc;
clear;
d1=0.42*10^-3 //distance between images obtained at position 1 in m
d2=1.21*10^-3 //distance between images obtained at position 2 in m
Beta_1=0.4*10^-3 //bandwidth in m at position 1
Beta_2=0.5*10^-3 //bandwidth in m at position 2
D2_minus_D1=0.60 //displacement in position in m

//calculation

d=sqrt(d1*d2) //distance between sources in m
lambda=(d*(Beta_2-Beta_1))/D2_minus_D1

mprintf("The wavelength of the source is = %1.3e m",lambda)
//The answer provided in the textbook is wrong.
```

Scilab code Exa 4.8 Biprism experiment

```
clc;
clear;
```

```
myu=1.45 //refractive index
t1=5*10^-6 //thickness of the sheet in m
Beta=0.3*10^-3 //bandwidth in m
lambda=5860*10^-10 //wavelength in m

//calculation
X_0=((myu-1)*t1*Beta)/lambda //shift of the central
    band in m
t2=(X_0*lambda)/(Beta*(myu-1))

mprintf("The thickness of the mica sheet is = %1.3e
    m.",t2)
//The answer provided in the textbook is wrong.
```

Scilab code Exa 4.9 Biprism experiment

```
clc;
clear;
Beta=0.2*10^-3 //bandwidth in m
myu=1.5 //refractive index of the biprism
myu_0=1.3 //refractive index of the liquid

//calculation
Beta_0=(Beta*(myu-1))/(myu-myu_0)
mprintf("The bandwidth when the setup is immersed in
    liquid is = %1.0e m",Beta_0)
```

Scilab code Exa 4.10 Biprism experiment

```
clc;
clear;
lambda1=6360 //wavelength in Angstrom
Beta2_by_Beta1=7.5/8 //Ratio of the fringes widths
Beta1_by_Beta2=7.5/8.5 //Ratio of the fringes widths

//calculation
//case (i)
lambda2=Beta2_by_Beta1*lambda1
mprintf("The wavelength  8th bright band is = %4.1f
    A\n",lambda2)

//case (ii)
lambda2=Beta1_by_Beta2*lambda1
mprintf("The wavelength  9th dark band is = %4.1f A"
    ,lambda2)
```

Scilab code Exa 4.11 Double slit experiment

```
clc;
clear;
lambda=4800*10^-10 //wavelength in m
n=5 //position occupied by the central bright fringe
myu=1.4 //refractive index of glass covering slit 1
myu_0=1.7 ////refractive index of glass covering
    slit 2

//calculation
t=(n*lambda)/(myu_0-myu)

mprintf("The thickness of the glass plate is = %1.1e
    m",t) //The answer provided in the textbook is
    wrong.
```

Scilab code Exa 4.12 Fresnels biprism experiment

```
clc;
clear;
n1=62 //no of fringes observed
lambda_1=5893 //wavelngth of sodium light in
    Angstrom
lambda_2=5461 //wavelength of mercury lamp in
    Angstrom

//calculation
n2=(n1*lambda_1)/lambda_2

mprintf("The fringes obtained when sodium lamp is
    replaced by a mercury lamp is = %d",n2)
//The answer varies due to round off error.
```

Scilab code Exa 4.13 Refractive index of oil

```
clc;
clear;
vol=0.2 //volume of a drop of oil in cubic
    centimeter
area=100*100 //area in cm^2
lambda=5.5*10^-5 //wavelength in m
r=0 //angle of incidence in degree
n=1 //number of dark band
```

```

//calculation
d=vol/area //thickness of the film of oil in cm
myu=(n*lambda)/(2*d*cosd(0))

mprintf("The refractive index of oil is = %1.3f",myu
   )
```

Scilab code Exa 4.14 `Reflection from soap film`

```
clc;
clear;
i=35 //angle of incidence in degree
myu=1.33 //refractive index
d=5*10^-5 //thickness of the soap film in cm
n1=1 //for first order
n2=2 //for second order
n3=3 //for third order
n4=4 //for fourth order

//calculation
r=asind(sind(i)/myu) //angle of refraction in degree

//case(1) for first order
lambda_1=(2*myu*d*cosd(r))/n1

//case(2) for second order
lambda_2=(2*myu*d*cosd(r))/n2

//case(3) for third order
lambda_3=(2*myu*d*cosd(r))/n3

//case(14) for fourth order
```

```
lambda_4=(2*myu*d*cosd(r))/n4


mprintf("\n The wavelength of light for first order
    is = %1.2e cm and it lies in the infrared region\
    n",lambda_1)
mprintf("\n The wavelength of light for second order
     is = %1.1e cm and it lies in the visible region\
    n",lambda_2)
mprintf("\n The wavelength of light for third order
    is = %1.1e cm and it lies in the visible region\n
    ",lambda_3)
mprintf("\n The wavelength of light for fourth order
     is = %1.1e cm and it lies in the ultravoilet(
    invisible) region\n",lambda_4)
mprintf("\nThe absent wavelengths in the reflected
    light are %1.1e cm and %1.1e cm",lambda_2,
    lambda_3)
```

Scilab code Exa 4.15 Wedge shaped air film

```
clc;
clear;
d=0.05*10^-3 //diameter of the wire in m
D=15 //distance between the glass plates and the
    edge in cm
lambda=6000*10^-10 //wavelength in m


//calculation
alpha=d/D //wedge angle in radian
Beta=lambda/(2*alpha)

```

```
mprintf("The fringe width is = %1.2f cm",Beta)
```

Scilab code Exa 4.16 Wedge shaped air film

```
clc;
clear;
alpha=0.01 //wedge angle in radian
lambda=6000*10^-10 //wavelength in m
n=10 //the fringe observed

//calculation
x=((2*n-1)*lambda)/(4*alpha)

mprintf("The distance at which the 10th fringe will
   be obtained from the edge of the wedge is = %1.2e
    m",x)
```

Scilab code Exa 4.17 Newtons Rings experiment

```
clc;
clear;
f=400 //focal length of lens in cm
myu=1.50 //refractive index
lambda=5460*10^-6 //wavelength in cm
n=5 //fifth bright ring

//calculation
R=(myu-1)*2*f //radius of curvature in cm

```

```
D5=sqrt(2*((2*n)-1)*lambda*R)

mprintf("The diameter of the fifth bright ring is =
    %1.2f cm",D5)
//The answer provided in the textbook is wrong.
```

Scilab code Exa 4.18 Newtons Rings experiment

```
clc;
clear;
D_4=0.4 //diameter of the 4th dark ring in cm
D_12=0.7 //diameter of the 12th dark ring in cm

//calculation
D_20=sqrt(2*((0.7^2)-(0.4^2))+0.4^2)
mprintf("The diameter of the 20th dark ring is = %1
    .3f cm",D_20)
```

Scilab code Exa 4.19 Newtons Rings experiment

```
clc;
clear;
D_10=1.40 //diameter of the 10th ring in air in cm
D_10_liquid=1.27 //diameter of the 10th ring in
    liquid in cm

//calculation
myu=D_10^2/D_10_liquid^2
```

```
mprintf("The refractive index of the liquid is = %1
    .3f",myu)
```

Scilab code Exa 4.20 Newtons Rings experiment

```
clc;
clear;
R=100 //radius of curvature in cm
D_5=0.3 //diameter of the 5th dark ring in cm
D_25=0.8 //diameter of the 25th dark ring in cm
n5=5 //fifth dark ring
n25=25 //twenty fifth ring

//calculation
p = n25 - n5 //difference in no of fringes
lambda=((D_25^2)-(D_5^2))/(4*p*R)

mprintf("The wavelength of light used is = %1.2e cm"
    ,lambda)
//The answer provided in the textbook is wrong.
```

Scilab code Exa 4.21 Michelsons interferometer

```
clc;
clear;
disp_X=0.05896*10^-3 //displacement of mirror in m
n=200 //no of fringes

//calculation
```

```
lambda=(2*disp_X)/n

mprintf("The wavelength of the light is = %1.3e m",
   lambda)
//The answer provided in the textbook is wrong.
```

Scilab code Exa 4.22 Michelsons interferometer

```
clc;
clear;
lambda_ave=5893*10^-10 //mean wavelength in m
X2_minus_X1=0.2945*10^-3 //displacement of mirror in
    m

//calculation
lambda1_minus_lambda2=lambda_ave^2/(2*X2_minus_X1)
mprintf("The difference in wavelengths is = %1.3e m"
   ,lambda1_minus_lambda2)
//The answer varies due to round off error.
```

Scilab code Exa 4.23 Michelsons interferometer

```
clc;
clear;
myu=1.5 //refractive index of glass plate
n=30 //no of fringes
d=0.018 //thickness of the plate in mm

//calculation
```

```
lambda=(2*(myu-1)*d)/n
mprintf("The wavelength of light used is = %4.0e m",
   lambda)
//The answer provided in the textbook is wrong.
```

Scilab code Exa 4.24 `Michelsons interferometer`

```
clc;
clear;
t=3 //thickness of air cell in cm
delta_myu=0.000230 //difference in pressure
lambda=5.46*10^-5 //wavelength in cm

//calculation
change_in_path=t*delta_myu // change in one way path
    in cm
n=(2*change_in_path)/lambda
mprintf("The no of fringes passing through the field
    of view is = %d",n)
```

Chapter 5

Diffraction

Scilab code Exa 5.1 Lines on grating surface

```
clc;
clear;
k=2
lambda=5*10^-5 //wavlength in cm
theta=30 //angle in degrees

//calculations
e=(k*lambda)/sind(theta) //in cm
mprintf("No. of lines per centimeter = %.0e",(1/e))
    //The answer provided in the textbook is wrong
```

Scilab code Exa 5.2 Difference in angle of deviation

```
clc;
clear;
```

```
lambda=5*10^-5 //wavelength in cm
e=1/6000 //No. of lines per centimeter on the
    grating surface

//calculation
//1st order
theta_1= asind(lambda/e) //angle in degree

//3rd order
theta_3= asind((3*lambda)/e) //angle in degree

angle_of_deviation = theta_3 - theta_1

printf("Difference in the angle of deviation in the
    first order and third order spectra = %1.1f
    degrees",angle_of_deviation)
```

Scilab code Exa 5.3 Number of grating lines

```
clc;
clear;
lambda=5890*10^-8 //wavelength in cm
k=2
d_lambda=(5896 - 5890)*10^-8 //grating width in cm
d=2.5 //grating width in cm

//calculation
N=lambda/(k*d_lambda) //No. of grating lines
No_of_lines = N/d

printf("No. of lines per cm = %1.1f",No_of_lines) //
    The answers vary due to round off error
```

Scilab code Exa 5.4 Spectral lines

```
clc;
clear;
lambda=5890*10^-8 //wavelength in cm
k1=1 //first order of wavelength
k2=2 //second order of wavelength
N=425 // grating lines per cm
d_lambda=(5896 - 5890)*10^-8 //grating width in cm
d=2 //grating width in cm

//calculation
Total_lines = N*2 //Total no. of lines on the grating

//for the first order
N1=ceil(lambda/(k1*d_lambda)) //No. of grating lines

//for the second order
N2=ceil(lambda/(k2*d_lambda)) //No. of grating lines

if(Total_lines>N1) then
    printf("\nAs the total number of lines required for the just resolution in the first order is %d and the total number of lines on the grating is %d, the lines will appear resolved in first order\n",N1,Total_lines)
else
    printf("\nAs the total number of lines required for the just resolution in the first order is %d and the total number of lines on the grating is %d, the lines will not be resolved
```

```
\n",N1,Total_lines)
end

if(Total_lines>N2) then
    printf("\nAs the total number of lines required is %d and the given grating has a total of %d lines, the lines will appear resolved in second order\n",N2,Total_lines)
else
    printf("\nAs the total number of lines required is %d and the given grating has a total of %d lines, the lines will not be resolved\n",N2,Total_lines)
end
```

Scilab code Exa 5.5 `Angle of seperation between lines`

```
clc;
clear;
lambda1=5016*10^-8 //wavelength in cm
lambda2=5048*10^-8 //wavelength in cm
N=15000 //lines per inch
k=2

//calculation
e=2.54/N //in cm
theta1_degrees= floor(asin((2*lambda1)/e)*(180/%pi)) //degrees part of angle
theta1_minutes=ceil((asin((2*lambda1)/e)*(180/%pi)-theta1_degrees)*60) //minutes part of angle
theta2_degrees = floor(asin((2*lambda2)/e)*(180/%pi)) //degrees part of angle
theta2_minutes=ceil((asin((2*lambda2)/e)*(180/%pi)-
```

```
    theta2_degrees)*60) //minutes part of angle


printf("Angle of separation = %d degrees %d minutes"
    ,(theta2_degrees-theta1_degrees),(theta2_minutes-
    theta1_minutes))
```

Scilab code Exa 5.6 Dispersive power of diffraction grating

```
clc;
clear;
lambda=5000*10^-8 //wavelength in cm
N=15000 //lines per inch
k=3
e=1/4000 //in cm

//calculation
sin_theta = (k*lambda)/e //in radian
cos_theta = sqrt(1-sin_theta^2) // in radian
disspersive_power = k/(e*cos_theta)

printf("Dispersive power of the grating in third
    order spectrum = %d",disspersive_power)
```

Scilab code Exa 5.7 Highest order spectrum

```
clc;
clear;
lambda=6000*10^-8 //wavelength in cm
```

```
N=5000 //lines per cm
k=3
e=1/5000 //in cm
sin_theta=1 //angle in radian

//calculation
k=(e*sin_theta)/lambda

printf("The highest order of spectrum that can be seen is %d",k)
```

Scilab code Exa 5.8 Wavelength of lines in second order spectrum

```
clc;
clear;
theta=10 //angle in degree
d_theta=3 //angle in degree
d_lambda=5*10^-9 //wavelength in cm
k=2

//calculation
lambda=(sind(theta)*d_lambda)/(cosd(theta)*(d_theta/(60*60))*(%pi/180)) // wavelength in cm
N=lambda/(d_lambda*k) //number of lines
Ne = (N*k*lambda)/sind(theta)

printf("Minimum grating width required = %1.1f cm",Ne)
```

Scilab code Exa 5.9 The grating element

```
clc;
clear;
sin_theta1=0.2 //angle in radian
sin_theta2=0.3 // angle in radian
lambda = 5000*10^-9 //wavelength in cm
d=2.5 //width of the grating surface in cm

//calculations
e=lambda/(sin_theta2-sin_theta1) //in cm
N=d/e //number or rulings
Rp=2*N

printf("Resolving power = %d",ceil(Rp))
```

Chapter 6

Polarization of light and Photoelasticity

Scilab code Exa 6.1 Polarizing angle

```
clc;
clear;
myu=1.5 // refractive index of glass

//calculation
i_p=atand(myu)


mprintf("The polarizing angle is = %1.2f degree",i_p
   )
```

Scilab code Exa 6.2 Quarter wave plate

```
clc;
clear;
lambda=6000*10^-10 //wavelength in m
myu_0=1.554 //refractive index
myu_e=1.544 //refractive index

//calculation
d=lambda/(4*(myu_0-myu_e))

mprintf("The thickness of the quarter wave plate is
   = %1.1e m",d)
```

Scilab code Exa 6.3 Quarter wave plate

```
clc;
clear;
d=12.5*10^-6 //thickness of the quarter wave plate
   in m
myu_diff=0.01 //difference in refractive indices

//calculation

lambda=d*4*(myu_diff)
mprintf("The wavelength is = %1.0e m",lambda)
```

Scilab code Exa 6.4 Quartz plate

```
clc;
clear;
```

```
myu_e=1.553 //refractive index
myu_0=1.542 //refractive index
lambda=5.5*10^-5//wavelength in m

//calculation for minimum thickness i.e half wave
   plate
d=lambda/(2*(myu_e-myu_0))

mprintf("The thickness of the plate is = %1.1e m",d)
    //The answer provided in the textbook is wrong.
```

Chapter 7

Laser

Scilab code Exa 7.1 Electric field of laser beam

```
clc;
clear;
P=10^-3 //power in watt
A=3*10^-6 //cross section area in m^2
n=1 //refractive index
c=3*10^8 //velocity of light in m/s
myu=4*10^-7 //vaccum permittivity

//calculation
I=P/A // Intensity in W/m^2s
E_0=sqrt((2*c*myu*I)/n)
mprintf("The electic field of the laser beam is = %d
    V/m",E_0)
//The answer provided in the textbook is wrong
```

Scilab code Exa 7.2 Electric field of a bulb

```
clc;
clear;
P=10 //power in watt
d=10 //distance from the source in m
n=1 //refractive index
c=3*10^8 //velocity of light in m/s
myu_0=4*10^-7 //vaccum permittivity

//calculation
I=P/(4*%pi*d^2) //intensity in W/m^2
E_0=sqrt(2*c*myu_0*I)/n

mprintf("The electric field of the bulb = %f V/m",
   E_0)
//The answer given in the textbook is wrong.
```

Scilab code Exa 7.3 Electric field intensity

```
clc;
clear;
P=10^-3 //power in watt
r=6*10^-3 //distance from the source in m
c=3*10^8 // velocity of light in m/s
myu_0=4*10^-7 //refractive index
n=1

//calculation

I=P/(%pi*(r^2)) //intensity in W/m^2
E=sqrt((2*c*myu_0*I)/n)
mprintf("The electric field at a point = %1.1e volt/
```

```
   m",E)
//The answer given in the textbook is wrong.
```

Scilab code Exa 7.4 Ratio of populations

```
clc;
clear;
lambda=694.3*10^-9 //wavelength in m
K_b=1.38*10^-23 //Boltzmann constant J/K
T=300 //Temperature in K
h=6.63*10^-34 //Plancks constant in J-s
c=3*10^8 //velocity of light in m/s

//calculation

N1_by_N2=exp(-(h*c)/(lambda*K_b*T))

mprintf("The ratio of population of two energy
   levels N1/N2 is = %1.2e",N1_by_N2)
//The answer provided in the textbook is wrong.
```

Scilab code Exa 7.5 Ratio of populations

```
clc;
clear;
N2_by_N1=10^-30 //ratio of energy levels
K_b=1.38*10^-23 //Boltzmann constant J/K
T=300 //Temperature in K
h=6.63*10^-34 //Plancks constant in J-s
```

```
c=3*10^8 //velocity of light in m/s

//calculation

lambda=(h*c)/(30*K_b*T)

mprintf("The wavelength of the radiation emitted is
    = %e m",lambda)
//The answer given in the textbook is wrong.
```

Scilab code Exa 7.6 Ratio of stimulated to spontaneous emission

```
clc;
clear;
lambda=694.3*10^-9 //wavelength in m
K_b=1.38*10^-23 //Boltzmann constant J/K
T=300 //Temperature in K
h=6.63*10^-34 //Plancks constant in J-s
c=3*10^8 //velocity of light in m/s

//calculation
Exp=(h*c)/(lambda*K_b*T) //exponential term of the
    formula
R=1/(exp(Exp)-1)

mprintf("The ratio of stimulated emission to
    spontaneoius emission is = %e",R)
//The answer provided in the textbook is wrong.
```

Scilab code Exa 7.7 No of photons emitted

```
clc;
clear;
P=1 //power in W
lambda=694.3*10^-9 //wavelength in m
h=6.63*10^-34 //Plancks constant in J-s
c=3*10^8 //velocity of light in m/s

//calculation
n=(P*lambda)/(h*c)

mprintf("The number of photons emitted per second =
   %1.2e",n)
```

Chapter 9

Fiber Optics

Scilab code Exa 9.1 No of modes in optical fiber

```
clc;
clear;
d=60 // diameter in micrometer
n1=1.48 //core refractive index
n2=1.41 //cladding refractive index
lambda=0.8 //wavelength of light source in
    micrometer

//calculation

NA=sqrt(n1^2-n2^2) //numerical aperture
V=(%pi*d*NA)/lambda //normalized frequency in cycles
    /sample
M=V^2/2

mprintf("The no of modes propogating in the fibre
    are %e",M)
//The answer provided in the textbook is wrong.
```

Scilab code Exa 9.2 Attenuation of light

```
clc;
clear;
alpha=2.2 //attenuation of light in dB/km
L1=2 //distance in km
L2=6 //distance in km

//calculation
//Case(a):when distance L = 2km
It_by_I0_1=10^-((alpha*L1)/10)

//Case(b):when distance L = 6km
It_by_I0_2=10^-((alpha*L2)/10)

mprintf("\nThe fraction of intial intensity that
   will remain after 2km is = %1.3f\n",It_by_I0_1)
   //The answer varies due to round off error.
mprintf("\nThe fraction of intial intensity that
   will remain after 6km is = %1.3f",It_by_I0_2) //
   The answer varies due to round off error.
```

Scilab code Exa 9.3 Angle of acceptance

```
clc;
clear;
n1=1.48 //core refractive index
delta=0.05 //fractional refractive index
```

```

//calculation
NA=n1*sqrt(2*delta) //numerical aperture
i_a=asind(NA)

mprintf("\nThe numerical aperture is = %1.3f\n",NA)
mprintf("The acceptance angle is = %2.1f degree.",
    i_a)
```

Scilab code Exa 9.4 Angle of acceptance

```
clc;
clear;
n1=1.45 //refractive index of core
n2=1.40 //refractive index of cladding

//calculation
NA=sqrt(n1^2-n2^2)
mprintf("\nThe numerical aperture is = %1.4f.\n",NA)

i_a=asind(NA)
mprintf("The acceptance angle is = %d degree.",i_a)
```

Scilab code Exa 9.5 Loss of specification

```
clc;
clear;
L=0.5 //length of the fibre in km
I_0=7.5*10^-6 //input power in Watt
```

```
I_t=8.6*10^-6 //output power in Watt

//calculation
alpha=-(10/L)*log10(I_0/I_t)

mprintf("The loss specification of the fibre is = -
    %1.1f dB/km",alpha)
//The answer varies dur to round off error.
```

Scilab code Exa 9.6 Core Cladding interface

```
clc;
clear;
n1=1.5 //core refractive index
delta=1.8*10^-2 //fractional refractive index
ratio=0.982 //ratio of cladding to core refractive
    index
c=3*10^8 //velocity of light in m/s

//calculation
NA=n1*sqrt(2*delta) //numerical aperture
mprintf("\nThe numerical aperture is = %1.3f\n",NA)

i_a=asind(0.285)
mprintf("The acceptance angle is = %2.1f degree\n",
    i_a)

i_c=asind(ratio)
mprintf("The critical angle at the core cladding
    interface is = %2.1f degree\n",i_c)

v_core=c/n1
mprintf("The velocity of light in the core is = %1.0
```

```
e m/s\n",v_core)

v_clad=c/(ratio*n1)
mprintf("The velocity of light in the cladding is =
%1.2e m/s",v_clad)
```

Scilab code Exa 9.7 Fiber length

```
clc;
clear;
alpha=-0.5 //attenuation in dB/km
I_t=2*10^-6 //input power in W
I_o=1.5*10^-3 //output power in W

//calculation
L=-(10/0.5)*log10(I_t/I_o)
mprintf("The length of the fibre is = %2.1f km.",L)
```

Chapter 10

Matter and Radiation Dual Nature

Scilab code Exa 10.1 Temperature of the star

```
clc;
clear;
T1=6000 //temperature of the sun in K
E1_by_E2=17000 //ratio of luminosity of sun to the
    star

//calculation

T2=T1*E1_by_E2^(1/4)
mprintf("The temperature of the star is = %d K",T2)
//Answer varies due to round off error
```

Scilab code Exa 10.2 Energy radiated per minute

```
clc;
clear;
e=0.85 //emissivity
T=2000 //Temperature in K
A=5*10^-5 //surface area in m^2
t=60 //time in s
sigma=5.7*10^-8 //Stefan-Boltzmann Constant in J/m^2
    sK^4

//calculation
Q=e*sigma*T^4*A*t
mprintf("The energy radiated per unit area per sec
    is = %d Joules.",Q)
//The answer varies due to round off error.
```

Scilab code Exa 10.3 Work function of a metal

```
clc;
clear;
h=4.136*10^-15 //Plancks constant in eV
c=3*10^8 //velocity of light in m/s
R=1.097*10^7 //Rydberg constant m^-1
lambda1= 900 //wavelength in nm
T1_by_T2=1/3    //Ratio of temperature T1 to T2
n1=2 //energy level of atom
n2=3 //energy level of atom

//calculation

lambda2=(lambda1*T1_by_T2)//wavelength in nm
E=(h*c)/(lambda2*10^-9) //Energy of incident photon
    in eV
Ex=R*h*c*((1/n1^2)-(1/n2^2)) //Excitation energy in
```

```
    eV
W=E-Ex

mprintf("The work function of the metal is = %1.2f
    eV",W)
```

Scilab code Exa 10.4 Temperature of the sun

```
clc;
clear;
S=1.4*10^3 //rate of suns energy striking in watt/m
    ^2
r=1.5*10^11 //radius of earths orbit in m
R=7*10^8 //radius of sun in m
sigma=5.7*10^-8 //Stefan-Boltzmann Constant in J/m^2
    sK^4

//calculation
T=((S*r^2)/(sigma*R^2))^(1/4)

mprintf("The surface temperature of the sun = %d K",
    T)
//The answer provided in the textbook is wrong.
```

Scilab code Exa 10.5 Cooling of the black body

```
clc;
clear;
T0=293 //temperature of the surrounding
```

```
T1=373 //temperature of the black body in case 1
T2=303 //temperature of the black body in case 2

//calculation

E1_by_E2=(T1^4-T0^4)/(T2^4-T0^4)
mprintf("The ratio of how much body cools in the
   first case to the second case is = %2.1f",
   E1_by_E2)
```

Scilab code Exa 10.6 Emissivity of a body

```
clc;
clear;
A=5*10^-4 //area in m^2
sigma=5.67*10^-8 //Stefan-Boltzmann Constant in J/m
   ^2sK^4
t=60 //time in s
T=727+273 //temperature in K
Q=300 //energy in J

//calculation

e=Q/(sigma*T^4*t*A)
mprintf("The emissivity of the surface area is = %1
   .2f",e)
```

Scilab code Exa 10.7 Cooling of a sphere

```
clc;
clear;
r=5*10^-2 //outer radius of copper sphere in m
T1=10^3//temperature in K
T2=300 //temperature in K
c=4*10^3 //specific heat in J/kg
rho=9*10^3 //density of copper in kg/m^3
sigma=5.67*10^-8 // Stefan-Boltzmann Constant in J/m
    ^2sK^4

//calculation
t=((rho*r*c)/(9*sigma))*((1/T2^3)-(1/T1^3))

mprintf("The time required to cool from 1000 to 300K
    is = %.2e sec or 127*10^3 sec\n",t)
```

Scilab code Exa 10.8 Current in the wire

```
clc;
clear;
rad=10^-3 //radius of wire in m
l=1 //length of the wire in m
T=900 //temperature of the body in K
T0=300 //temperature of the surrounding in K
sigma=5.68*10^-8 // Stefan-Boltzmann Constant in J/m
    ^2sK^4
alpha=7.8*10^-3 //temperature coefficient of
    resistance
delta_T=600 //difference in temperature of the body
    and surrounding in K
rho_300=%pi^2*10^-8 //resistivity in ohm-m

//calculation
```

```
E=sigma*(T^4-T0^4)*2*%pi*rad*l //in watt
rho_900=((1+alpha*delta_T)*rho_300)// resistivity in
    ohm-m
R_900=rho_900*(1/(%pi*rad^2)) //resistance in ohm
I=sqrt(E/R_900)
mprintf("The current in the wire is %d amp.",I)
```

Scilab code Exa 10.9 Energy density of a black body

```
clc;
clear;
h=6.63*10^-34 //Plancks constant in Joule-s
c=3*10^8 //velocity of light in m/s
lambda1=10^-3 //wavelength in m
lambda2=100*10^-9 //wavelength in m
T=1000 //temperature in K
k_B=1.38*10^-23 //Boltzmann constant in m^2 kg s^-2
    K^-1
d_lambda1=0.1*10^-3 //range of wavelength in m
d_lambda2=1*10^-9 //range of wavelength in m

//calculation
//case (a) when the range of wavelength is between
    1-1.1 mm
E=exp((h*c)/(lambda1*k_B*T)) //calculating the
    exponential term of the eqn
U_lambda1=((8*%pi*h*c*d_lambda1)/(lambda1^5*(E-1)))
mprintf("The energy density for wavelength in range
    1-1.1 mm is = %1.2e J/m^3.\n",U_lambda1)

//case (b) when the range of wavelength is between
    100-101 nm
E1=exp((h*c)/(lambda2*k_B*T)) //calculating the
    exponential term of the eqn
U_lambda2=((8*%pi*h*c*d_lambda2)/(lambda2^5*(E1-1)))
```

```
mprintf("The energy density for wavelength in range
    100-101 mm is = %1.2e J/m^3.",U_lambda2)
//The answer provided in the textbook is wrong.

mprintf("\nThus for shorter wavelengths the energy
    densities predicted by Rayleigh-Jeans law and
    Planks law are considerably different while for
    longer wavelengths the energy densites predicted
    are same.")
```

Scilab code Exa 10.10 Photoelectric effect

```
clc;
clear;
W=2.3*1.6*10^-19 //Energy required to remove
    electron in eV
h=6.63*10^-34 //Plancks constant in J-s
c=3*10^8 //velocity of light in m/s

//calculation
lambda_0=(h*c)/W
printf("\n The threshold wavelength is %1.3e.",
    lambda_0)
//The answer provided in the textbook is wrong.
```

Scilab code Exa 10.11 Retarding potential

```
clc;
clear;
```

```
W=1.2*1.6*10^-19 //work function in eV
h=6.6*10^-34 //Plancks constant in J-s
v=5.5*10^14 // frequency of light in Hz
e=1.6*10^-19 //charge in C

V_s=((h*v)-W)/e

mprintf("The stopping potential is = %1.2f volt",V_s
   )
//Answer varies due to round off error.
```

Scilab code Exa 10.12 Photoelectric effect

```
clc;
clear;
h=6.63*10^-34 //Plancks constant in J-s
v0=6*10^14 // threshold frequency of light in Hz
e=1.6*10^-19 //charge in C
V_s=3 //stopping potential in V

//calculation
v=((e*V_s)/h)+v0
mprintf("The frequency of light which ejects
   electrons from the surface is %1.3e Hz",v)
```

Scilab code Exa 10.13 Photoelectric effect

```
clc;
clear;
```

```
h=6.63*10^-34 //Plancks constant in J-s
v=3*10^8 // frequency of light in Hz
e=1.6*10^-19 //charge in C
lambda=200*10^-9 //wavelength in m
W=4.2 //work function in Joule
c=3*10^8 //velocity of light in m/s

//calculation
E=(h*c)/(lambda)//energy in J
E_v=E/e //energy in eV

//case (1)
//(a)
E_k=E_v-W
mprintf("The kinetic energy of the fastest electrons
    is = %d eV\n",E_k)

//(b)
mprintf("The kinetic energy of slowest electrons is
   zero. As the emitted electrons have all possible
   energies from 0 to certain maximun value is E_k =
    %d eV \n",E_k)

//case(2)
mprintf("If V_s is the stopping potential then E_k=e
   *V_s.Since the electrons have a maximum kinetic
   energy of %d eV,the stopping potential is also
   E_k = %d eV \n",E_k,E_k)

//case(3)
lambda_0=(h*c)/(W*e)
mprintf("The cut off wavelength for aluminium is %1
   .1e m",lambda_0)
```

Scilab code Exa 10.14 Work function for caesium

```
clc;
clear;
P=10^-3 //power in watt
h=6.62*10^-34 //Plancks constant in J-s
v=3*10^8 //frequncy of light in Hz
lambda=4560*10^-10 //wavelength in m
eff=0.005 //quantum efficiency
e=1.6*10^-19 //charge in C

//calculation
E=(h*v)/lambda //energy of each photon in joules
N=P/E //no of photons incident on the metal per sec
N_e=N*eff //no of electrons released per sec
I=N_e*e

mprintf("The photoelectric current is = %1.3f micro-
    amp",I*10^6) //multiplying by 10^6 to convert
    from ampere to micro-ampere.
//The Answer provided in the textbook is wrong.
```

Scilab code Exa 10.15 Photoelectric effect

```
clc;
clear;
lambda1=400*10^-9 //wavelength in m
lambda2=300*10^-9 //wavelength in m
V1=0.82 //stopping potential in V
V2=1.85 //stopping potential in V
c=3*10^8 //velocity of light in m/s
e=1.6*10^-19 //charge in C

```

```
//calculation
h=(e*(V1-V2)*(lambda1)*(lambda2))/(c*(lambda2-lambda1))

mprintf("\nThe Plancks constant is = %1.3e J-s\n",h)
mprintf("The photoelectric current will not be obtained as the stopping potential does not depend on the intensity of light")
```

Scilab code Exa 10.16 Photoelectric effect

```
clc;
clear;
h=6.63*10^-34 //plancks constant in J-s
c=3*10^8 //velocity of light in m/s
lambda=180*10^-9 //wavelength in m
W=2*1.6*10^-19 //work function in Joule
m=9.1*10^-31 //mass in kg
e=1.6*10^-19 //charge in C
B=5*10^-5 //magnetic flux density in Tesla

//calculation
E=((h*c)/lambda)-W //kinetic energy in J
v=sqrt((2*E)/m) //velocity in m/s
r=(m*v)/(e*B)

mprintf("The radius of the circular path in magnetic field is = %1.3f m",r)
```

Scilab code Exa 10.17 Scattering angle

```
clc;
clear;
h=6.63*10^-34 //Plancks constant in J-s
c=3*10^8 //velocity of light in m/s
E0=6.20*10^3 //energy of photon in keV
freq_s=0.5/100 //frequency shift
m=9.1*10^-31 //mass in kg



//CALCULATION
lambda0=(h*c)/(E0*1.6*10^-19) //wavelength in m
delta_E=(freq_s*E0)/10^3 //Loss in energy of photon
    in keV
E=(E0/10^3)-delta_E //energy of scattered photon on
    keV
lambda=(h*c)/(E*10^3*1.6*10^-19) //wavelength of
    scattered photon in m
delta_lambda=lambda-lambda0 //compton shift
phi=acosd(1-(m*c*delta_lambda)/h)

mprintf("The angle through which Xray is scattered
    is = %2.1f degree",phi)
//The answer varies due to round off error.
```

Scilab code Exa 10.18 Compton shift

```
clc;
clear;
h=6.63*10^-34 //Plancks constant in J-s
c=3*10^8 //velocity of light in m/s
```

```
m=9.1*10^-31 //mass in kg
lambda_1=100*10^-12 //wavelength in m
e=1.6*10^-19 //charge in C


//calculation
delta_lambda=(h/(m*c)) //wavelength in m
mprintf("The compton shift is = %1.2e m\n",
   delta_lambda)

lambda_0=lambda_1-delta_lambda //wavelength of the
   scattered photon in m
delta_E=(h*c*delta_lambda)/(lambda_1*lambda_0)
mprintf("\nThe kinetic energy imparted to the
   electron is = %1.2e J or %1.2f eV",delta_E,
   delta_E/e)
//The answer provided in the textbook is wrong.
```

Scilab code Exa 10.20 Scattering angle

```
clc;
clear;
E0=100 //energy of the incident photon in keV
E=90 //energy of the scattered photon in keV
m=9.1*10^-31 //mass in kg
c=3*10^8 //velocity of light in m/s

//calculation
delta_E=E0-E //energy lost in keV
mc_square=(m*c^2)/(1.6*10^-19*10^3) //calculating
   one part of the formula
phi=acosd(1-(delta_E/E*mc_square/E0))

```

```
mprintf("The scattering angle of the photon is = %2
    .1f degree",phi)
```

Scilab code Exa 10.21 DeBroglie wavelength

```
clc;
clear;
KE=10*1.6*10^-19 //energy in J
m=9.1*10^-31 //mass in kg
h=6.63*10^-34 //Plancks constant in J-s
m_h=2*10^-3 //molecular weight of hydrogen in kg
a=6.023*10^23 //Avogadros constant in mol^-1
v=2200 //velocity in m/s
m_g=45*10^-3 //mass of golf ball in kg]
v_g=22 //velocity of golf ball in m/s

//calculation
//case (a)
lambda=((h/sqrt(2*m*KE))/10^-9) //converting from m
    to nm by dividing by 10^-9
mprintf("The de-Broglie wavelength is = %1.3f nm\n",
    lambda) //The answer varies due to round off
    error.

//case (b)
m=m_h/a //mass in kg
lambda=((h/(m*v))/10^-9) //converting from m to nm
    by dividing by 10^-9
mprintf("The de-Broglie wavelength is = %1.3f nm \n"
    ,lambda)

lambda1=h/(m_g*v_g) //Wavelength in m
mprintf("The de-Broglie wavelength of the golf ball
```

```
    is = %1.1e m",lambda1)
```

Scilab code Exa 10.22 DeBroglie wavelength

```
clc;
clear;
h=6.63*10^-34 //Plancks constant in J-s
K_b=1.38*10^-23 //Boltzmanns constant in m^2 kg s
    ^-2 K^-1
T=300 //Temperature in K
m=1.00878*1.66*10^-27 //mass of neutron in kg

//calculation
lambda=((h/sqrt(3*m*K_b*T))/10^-9) //converting from
    m to nm by dividing by 10^-9 ,wavelength in nm

mprintf("The de-Broglie wavelength is = %1.3f nm",
    lambda)
```

Scilab code Exa 10.23 DeBroglie wavelength

```
clc;
clear;
m=9.1*10^-31 //mass in kg
h=6.63*10^-34 //Plancks constant in J-s
e=1.6*10^-19 //charge in C
lambda=0.1 //wavelength in nm

//calculation
```

```
V=(((h/(sqrt(2*m*e)))*10^9)/(lambda))^2 //multipyling by 10^9 to convert from m to nm according to textbook convention,voltage in volts

mprintf("The voltage to which electron can be accelerated is = %3.2f volts",V)
//The answer varies due to round off error.
```

Scilab code Exa 10.24 DeBroglie wavelength

```
clc;
clear;
KE=0.04*1.6*10^-19 //energy in J
m=1.675*10^-27 //mass of neutron in kg
h=6.63*10^-34 //Plancks constant in J-s
c=3*10^8 //velocity of light in m/s

//calculation
lambda=(h/sqrt(2*m*KE))/10^-9 //Wavelength in nm
v_g=h/(lambda*10^-9*m) //Group Velocity in m/s
v_p=(c^2)/v_g //Phase Velocity in m/s
E=(h*c)/(lambda*10^-9) //Energy of neutron in J

mprintf("The de-Broglie wavelength is = %1.3f nm\n",lambda)
mprintf("The group velocity is = %1.2e m/s\n",v_g)
mprintf("The phase velocity is = %1.2e m/s\n",v_p)
mprintf("The energy of the neutron is = %1.2e J",E)
```

Scilab code Exa 10.25 Group velocity for wave packet

```
clc;
clear;
g=9.8 //acceleration  due to gravity in m/s^2
lambda=10 //wavelength in m

//calculation

v_g=sqrt((lambda*g*%pi)/2)
mprintf("The group velocity is = %2.2f m/s",v_g)
```

Scilab code Exa 10.26 Braggs reflection

```
clc;
clear;
m=9.1*10^-31 //mass in kg
h=6.63*10^-34 //Plancks constant in J-s
e=1.6*10^-19 //charge in C
n=1 //first reflection maximum
tetha=60 //glancing angle
V=344 //voltage in V

//calculation
d=((n*h)/(2*sind(60)*sqrt(2*m*e*V)))/10^-9
mprintf("The interplanar distance is = %1.3f nm",d)
```

Scilab code Exa 10.27 Braggs spectrum

```
clc;
clear;
m=1.675*10^-27//mass of neutron in kg
h=6.63*10^-34 //Plancks constant in J-s
n=1 //first reflection maximum
KE=0.04*1.6*10^-19 //energy in J
d=0.314*10^-9 //interplanar distance in m

//calculation

phi=asind((n*h)/(2*d*sqrt(2*m*KE)))
mprintf("The glancing angle is = %2.1f degree",phi)
//The answer varies due to round off error.
```

Scilab code Exa 10.28 Davisson Germer experiment

```
clc;
clear;
tetha=55 //braggs angle in degree
KE=0.25*1.6*10^-19 //enrgy in J
m=1.675*10^-27//mass of neutron in kg
h=6.63*10^-34 //Plancks constant in J-s
n=1 //first reflection maximum

//calculation
d=((n*h)/(2*sind(tetha)*sqrt(2*m*KE)))
mprintf("The interplanar distance is = %1.1e m",d)
```

Scilab code Exa 10.29 Accuracy in locating position of electron

```
clc;
clear;
m=9.1*10^-31 //mass of electron in kg
v=4*10^5 //velocity in m/s
u=10^-4 //uncertainity in momentum
h=6.63*10^-34 //plancks constant in J-s


//calculation
delta_p=u*m*v //in kg-m/s
delta_x=h/(2*%pi*delta_p*10^-9) //dividing by 10^-9
    to convert into nm to calculate uncertainity

mprintf("The uncertainity in the position of the
    electron is greater than or equal to %4.2f nm",
    delta_x) //The answer provided in the textbook is
     wrong.
```

Scilab code Exa 10.30 `Uncertainity of veliocity`

```
clc;
clear;

//calculation
deltap_by_p=((1/(4*%pi))*100) //multiplying by 100
    to calculate percentage

mprintf("The percent uncertainity in its velocity is
     less than equal to %1.2f",deltap_by_p)//The
    answer varies due to round off error.
```

Scilab code Exa 10.31 Uncertainity in momentum

```
clc;
clear;
delta_x=5*10^-14 //diameter of nucleus in m
h=6.63*10^-34 //plancks constant
m=1.675*10^-27 //mass in kg

//calculation
p_min=h/(4*%pi*delta_x) //minimum momentum in kg-m/s
E_min=((p_min)^2/(2*m))

mprintf("The minimum kinetic energy of the nucleon
    is = %0.2e J",E_min)
```

Scilab code Exa 10.32 Laser transition

```
clc;
clear;
h=6.63*10^-34 //Plancks constant in J-s
c=3*10^8 //velocity of light in m/s
lambda=694.5*10^-9 //wavelength in m
delta_t=10^-3

//calculation
delta_lambda=abs(-(lambda^2/(4*%pi*c*delta_t)))

```

```
mprintf("The natural line width of laser transition
    is = %1.2e m",delta_lambda)
//The answer provided in the textbook is wrong.
```

Chapter 11

X rays

Scilab code Exa 11.1 No of electrons in the X ray spectrum

```
clc;
clear;
I=10*10^-3 //current in Ampere
e=1.6*10^-19 //charge in C
h=6.63*10^-34 //Plancks constant in J-s
c=3*10^8 //velocity of light in m/s
V=25*10^3//voltage in V

n=(I/e)
mprintf("The no of electrons striking the target are
    = %1.2e\n",n)

lambda_min=(h*c)/(e*V)
mprintf("The minimum wavelegth of the emitted Xrays
    is = %1.2e m",lambda_min)
```

Scilab code Exa 11.2 Interplanar spacing to obtain second order maxima

```
clc;
clear;
e=1.6*10^-19 //charge in C
h=6.63*10^-34 //Plancks constant in J-s
c=3*10^8 //velocity of light in m/s
n1=1 //first order maxima
n2=2 //second order maxima
V=50*10^3 //voltage in V
tetha=26 //Braggs angle in degree

//calculation
lambda_min=(h*c)/(e*V) //wavelength in m
d=(n1*lambda_min)/(2*sind(tetha))
mprintf("The interplanar spacing is = %1.2e m\n",d)

tetha2=asind((n2*lambda_min)/(2*d))
mprintf("The Braggs angle for second order
    reflection is = %2.1f degree",tetha2) //The
    answer varies due to round off error.
```

Scilab code Exa 11.3 Wavelength to produce intensity maxima

```
clc;
clear;
d=275 //interplanar distance in pm
tetha=45 //glancing angle in degree

//calculation
//case(1) when intensity maxima is 3
n1=3
lambda=(2*d*sind(tetha))/n1
disp("case (1)")
mprintf("The wavelength for n = %d is = %d pm\n",n1,
```

```
ceil(lambda))

//case(2) when intensity maxima is 4
n2=4
lambda=(2*d*sind(tetha))/n2
disp("case (2)")
mprintf("The wavelength for n = %d is = %1.1f pm\n",
    n2,lambda)
////The answer varies due to round off error.


mprintf("Only for n=%d and n=%d,the value of lambda
    lies within the range 95 pm to 140 pm. Hence
    Bragg reflections are observed only for these two
     wavelengths",n1,n2)
```

Scilab code Exa 11.4 Line of wavelength

```
clc;
clear;
lambda=0.180*10^-9 //wavelength in m
R=1.097*10^7 // in m^-1

//calculation
Z_star=sqrt(4/(3*lambda*R))
mprintf("The Z_star is = %d",Z_star)
Z=(Z_star+1)
mprintf("The atomic number is = %d",Z)
```

```
--------------------------------------------------------------------------------------------------------------

--------------------------------------------------------------------------------------------------------------

+
```

```
+1)
mprintf("Atomic no is = %d, hence the element is
    cobalt",Z)
```

Scilab code Exa 11.5 `Identifying impurity element`

```
clc;
clear;
h=6.63*10^-34 //Plancks constant in J-s
c=3*10^8 //velocity of light in m/s
lambda=0.194*10^-9 //wavelength in m
E_ca=3.69 //energy of calcium target in keV
Z_ca=20 //atomic no of calcium
//calculation

E_imp=((h*c)/(lambda*1.6*10^-19))/10^3
Z_imp=(sqrt(E_imp/E_ca)*(Z_ca-1)+1)

mprintf("The atomic no is = %d, hence impurity is
    iron",Z_imp)
```

Scilab code Exa 11.6 `Miller Indices`

```
clc;
clear;
unit_cell_edge_x=(2) //intercept of x
unit_cell_edge_y=(-3) //intercept of y
unit_cell_edge_z=(6) //intercept of z

//calculations
Reciprocal_x=1/unit_cell_edge_x //reciprocal value
    of miller index x
Reciprocal_y=1/unit_cell_edge_y //reciprocal value
    of miller index y
Reciprocal_z=1/unit_cell_edge_z //reciprocal value
    of miller index z
Reciprocal_xyz=int32([unit_cell_edge_x,
    unit_cell_edge_y,unit_cell_edge_z]) //creating
    integer vector for LCM calculation
LCM=double(lcm(Reciprocal_xyz)) //LCM of unit cell
    edges
coordinate_A=(Reciprocal_x)*LCM
coordinate_B=Reciprocal_y*LCM
coordinate_C=Reciprocal_z*LCM

mprintf("The required miller indices of the plane
    are (%d,%d,%d).",coordinate_A,coordinate_B,
    coordinate_C)
```

Scilab code Exa 11.7 Miller Indices

```
clc;
clear;
unit_cell_edge_x=%inf //intercept of x
unit_cell_edge_y=1 //intercept of y
unit_cell_edge_z=(2/3) //intercept of z
```

```
//calculations
Reciprocal_x=1/unit_cell_edge_x //reciprocal value
    of miller index x
Reciprocal_y=1/unit_cell_edge_y //reciprocal value
    of miller index y
Reciprocal_z=1/unit_cell_edge_z //reciprocal value
    of miller index z
Reciprocal_xyz=[1,1,2]//creating integer vector for
    LCM calculation of numerator of all unit cell
    edges since denominator consists of 0 and LCM is
    1
LCM=double((lcm(Reciprocal_xyz))) //LCM of unit cell
     edges
coordinate_A=(Reciprocal_x)*LCM
coordinate_B=Reciprocal_y*LCM
coordinate_C=(Reciprocal_z)*LCM

mprintf("The required miller indices of the plane
    are (%d,%d,%d).",coordinate_A,coordinate_B,
    coordinate_C)
```

Scilab code Exa 11.8 Miller Indices

```
clc;
clear;
OA=0.121 //cell parameter in nm
OB=0.184 //cell parameter in nm
OC=0.197 //cell parameter in nm
OA_by_OB=3/2 //ratio of fractional intercepts
OA_by_OC=1/2 //ratio of fractional intercepts

//calculation
```

```
OB=((2/3)*OB)
OC=(2)*OC
mprintf("The intercepts along along the y and the z
   axes is = %1.3f nm and %1.3f nm",OB,OC)
```

Scilab code Exa 11.9 Interplanar distance in a crystal

```
clc;
clear;
a=0.82 //cell parameter in nm
b=0.94 //cell parameter in nm
c=0.75 //cell parameter in nm
h=1 //x intercept of parallel plane
k=2 // intercept of parallel plane
l=3 //z intercept of parallel plane

//calculation
d_123=((h/a)^2+(k/b)^2+(l/c)^2)^(-1/2)
d_246=d_123/2
mprintf("The interplanar distance between 123 planes
    is = %1.2f and 246 planes is = %1.3f",d_123,
   d_246)
//The answer provided in the textbook is wrong.
```

Scilab code Exa 11.10 Interplanar spacing in the reflecting planes

```
clc;
clear;
lambda=0.12 //wavelength in nm
```

```
tetha=28 //Braggs angle in degree
n=2 //second order reflection

//calculation
d=(n*lambda)/(2*sind(28))

mprintf("The interplanar spacing of the reflecting
    planes of the crystal is = %1.2f nm",d)
```

Scilab code Exa 11.11 Braggs reflection

```
clc;
clear;
n=3 //third order reflection
lambda=97 //wavelength in pm (third order)
tetha1=23 //Braggs angle for first order in degree
tetha2=60 //Braggs angle for third order in degree

//calculation
lambda_1=(n*lambda*sind(tetha1))/sind(tetha2)
d=(n*lambda)/(2*sind(tetha2))

mprintf("\nThe wavelength that undergoes first order
    reflection is = %d pm\n",lambda_1)
mprintf("The interplanar spacing is = %d pm",d)
```

Scilab code Exa 11.12 Braggs reflection

```
clc;
```

```
clear;
a=0.2 //lattice parameter in nm
h=1 //x intercept of parallel plane
k=1 //y intercept of parallel plane
l=1 //z intercept of parallel plane
phi=87 //incident angle in degree

//calculation
tetha=phi/2
d=(a/sqrt(h^2+k^2+l^2))
lambda=(2*d*sind(tetha))

mprintf("The wavelength is = %1.3f nm\n",lambda)
mprintf("The Braggs angle is = %2.1f degree",tetha)
```

Scilab code Exa 11.13 Interplanar spacing in Braggs reflection

```
clc;
clear;
h=6.63*10^-34 //Plancks constant in J-s
m=9.1*10^-31 //mass in kg
e=1.6*10^-19 //charge in C
V_0=844 //voltage in V
n=1 //first order reflection
tetha=58 //Braggs angle in degree

//calculation
lambda=(h/sqrt(2*m*e*V_0)) //wavelength in m
d=((n*lambda)/(2*sind(tetha)))
mprintf("The interplanar spacing is = %1.2e m",d)
//The answer varies due to round off error.
```

Scilab code Exa 11.14 Lattice constant

```
clc;
clear;
h=6.63*10^-34 //Plancks constant in J-s
m=1.804*10^-27 //mass of neutron in kg
K_b=1.38*10^-23 //Boltzmann constant in J/K
tetha=30 //Braggs angle in degree
n=2 //second order reflection
T=300 //temperature in K

//calculation
lambda=h/sqrt(3*m*K_b*T)
a=sqrt((3*lambda))/2

mprintf("The lattice constant is = %1.2e m.",a)
//The answer provided in the textbook is wrong.
```

Scilab code Exa 11.15 Unit cell dimensions

```
clc;
clear;
//from the table given in the sum, first observation
    is taken to calculate the unit cell and
   dimension
theta=6.05 //degree in radians
lambda=71 //wavelength in pm
h=1 //lattice parameter for x axis
```

```
k=0 //lattice parameter for y axis
l=0 //lattice parameter for z axis

//calculations
sin_square_theta=sind(theta)^2 //angle in degrees
alpha=(lambda/2)*((h^2+k^2+l^2)/sqrt(
   sin_square_theta))

mprintf("The lattice constant is alpha = %d pm",ceil
   (alpha))
```

Scilab code Exa 11.16 Lattice constant and cubic structure

```
clc;
clear;
lambda=0.154 //wavelength in nm
theta1=20 //angle in degree
theta2=29 //angle in degree
h=1 //x intercept of parallel plane
k=1 //y intercept of parallel plane
l=0 //z intercept of parallel plane
//calculation
ratio=sind(theta1)^2/sind(theta2)^2 //ratio of sin^2
    theta values of first and second angles
alpha=(lambda/2)*sqrt((sqrt(h^2+k^2+l^2))/sind(
   theta1)^2)

mprintf("The crystal structure is bcc since the
   ratio is %1.1f\n",ratio)
mprintf("lattice constant alpha = %0.3f nm\n",alpha)
    // The answer provided in the textbook is wrong
```

Scilab code Exa 11.17 `Lattice parameter and cubic structure`

```
clc;
clear;
//Consider the peak value 8 of observation for
   calculation in the sum
lambda=0.07107 //wavelength in nm
theta=29.71 //angle in degree
h=4 //x intercept of parallel plane
k=0 //y intercept of parallel plane
l=0 //z intercept of parallel plane

//calculation
d_400=(lambda/(2*sind(theta))) //interplanar
   distance in nm
alpha=d_400*(sqrt(h^2+k^2+l^2))

mprintf("lattice constant of peak no.1 is (110)\n")
```

Scilab code Exa 11.18 `Effective temperature of neutron`

```
clc;
clear;
h=1 //x intercept of parallel plane
k=1 //y intercept of parallel plane
l=1 //z intercept of parallel plane
a=0.352 //lattice constant in nm
tetha=28.5 //Braggs angle in degree
```

```
K_b=1.38*10^-23 //Boltzmann constant in J/K
H=6.63*10^-34 //Plancks constant in J-s
m=1.67*10^-27 //mass of nuetron in kg

//calculation

d=(a/sqrt(h^2+k^2+l^2)) //interplanar distance in nm
lambda=2*d*sind(28.5) //wavelength in nm
T=(H^2)/(3*m*K_b*((lambda*10^-9)^2))

mprintf("The effective temperature of neutrons is =
    %d K",T)
```

Scilab code Exa 11.19 Braggs angle

```
clc;
clear;
H=6.626*10^-34 //Plancks constant in J-s
m=9.1*10^-31 //mass in kg
e=1.6*10^-19 //charge in C
V_0=80 //Potential difference in V
a=0.35 //lattice parameter in nm
h=1 //x intercept of parallel plane
k=1 //y intercept of parallel plane
l=1 //z intercept of parallel plane

//calculation
lambda=H/sqrt(2*m*e*V_0) //wavelength in m
d_111=(a/sqrt(h^2+k^2+l^2))*10^-9 //interplanar
    distance in m
theta1_degrees= floor(asin((lambda)/(2*d_111))*(180/
```

```
%pi)) //degrees part of angle
theta1_minutes=((asin((lambda)/(2*d_111))*(180/%pi))-theta1_degrees)*60 //minutes part of angle
mprintf("The Braggs angle is = %d degrees and %d minutes",theta1_degrees,theta1_minutes)
//The answer varies due to round off error.
```

Scilab code Exa 11.20 Braggs reflection

```
clc;
clear;
tetha_A=21 //Braggs angle in degree
tetha_B_degree=21 // part of Braggs angle in degree
tetha_B_minute=23 //part of Braggs angle in minute
h=1 //x intercept of parallel plane
k=1 //y intercept of parallel plane
l=1 //z intercept of parallel plane
lambda=0.152 //wavelength of xray in nm

//calculation
//case(1) for sample A
d_111=lambda/(2*sind(tetha_A))
a=d_111*sqrt(h^2+k^2+l^2)
mprintf("\nThe lattice parameter of sample A is=  %1.3f nm\n",a)

//case(2) for sample B
tetha_B_decdeg=tetha_B_degree+(tetha_B_minute/60)
d_111=lambda/(2*sind(tetha_B_decdeg))
a=d_111*sqrt(h^2+k^2+l^2)
mprintf("The lattice parameter of sample B is = %1.3f nm\n",a)
```

Scilab code Exa 11.21 Braggs reflection

```
clc;
clear;
lambda=0.171 //wavelength of X-ray in nm
tetha_1=30 //Braggs angle in degree
tetha_2_degrees=35 //part of Braggs angle in degrees
tetha_2_minutes=17 //part of Braggs angle in minutes
h=1 //x intercept of the parallel plane
k=1 //y intercept of the parallel plane
l=0 //z intercept of the parallel plane

//calculation
//case(A)
d_110=lambda/(2*sind(tetha_1))
a=d_110*sqrt(h^2+k^2+l^2)
mprintf("(i)The lattice parameter is = %1.3f nm\n",a
    )

//case(B)
h=2 //x intercept of the parallel plane
k=0 //y intercept of the parallel plane
l=0 //z intercept of the parallel plane
tetha_2_decdeg=tetha_2_degrees+(tetha_2_minutes/60)
d_110=lambda/(2*sind(tetha_2_decdeg))
a=d_110*sqrt(h^2+k^2+l^2)
mprintf("(ii)The lattice parameter is = %1.4f nm\n",
    a)
mprintf("The lattice parameter is consistent at
    value=0.296 nm\n") //by multiplying d_110 by sqrt
    (3) and d_200 by sqrt(4)

```

```
//for atomice diameter we have
a=0.296 //lattice parameter in nm
D=a/sqrt(2)
mprintf("(iii)The atomic diameter is = %1.4f nm",D)
```

Scilab code Exa 11.22 Braggs reflection

```
clc;
clear;
lambda=0.154 //wavelength in nm
D=0.2494 //diameter in D

//calculation
d=lambda/2 //interplanar distance in nm
hkl_parameters=((2*D)/(d*sqrt(3)))^2



mprintf("The highest possible values of hkl are
   (222) as the sum total of h^2+k^2+l^2 is less
   than or equal to %1.2f\n",hkl_parameters)//The
   answer varies dur to round off error
mprintf("Braggs reflection will occur from the first
    planes including (222)")
```

Chapter 12

Basic Quantum Mechanics

Scilab code Exa 12.1 Energy and momentum of the particle

```
clc;
clear;
m=1.67*10^-27 //mass of particle in kPP
L=0.1*10^-9 //width in nm
n=3 //quantum number
h=6.63*10^-34 //Plancks constant in J-s

//calculation
//(1)
E=(n^2*h^2)/(8*m*L^2)
mprintf("The energy of the particle is = %2.2e
   Joules\n",E)
//The answer provided in the textbook is wrong.

//(2)
lambda=(2*L)/n
p=h/lambda
mprintf("The momentum of the particle is = %1.2e kg-
   ms^-1\n",p)
```

```
//(3)
P=((1/L)*(L/3)) //after integration
mprintf("The probability of finding particle between
    x=0 and x=L/3 is = %f",P)
```

Scilab code Exa 12.2 Wavelength of radiation

```
clc;
clear;
h=6.63*10^-34 //Plancks constant in J-s
m=9.1*10^-31 //mass in kg
L=10^-9 //potential width in m
c=3*10^8 //velocity of light in m/s

//calculation
lambda=(8*m*c*L^2)/(27*h)
mprintf("The wavelength of radiation emitted is %1.2
    e m or 122 nm",lambda)
//The answer varies due to round off error.
```

Scilab code Exa 12.3 Uncertainity in momentum

```
clc;
clear;
delta_x=10^-9 //uncertainity in the position of
    electron in m
h=6.63*10^-34 //Plancks constant in J-s

```

```
//calculation
delta_p=h/(4*%pi*delta_x)

mprintf("The uncertainity in momentum of the electron is greater than or equal to %1.1e kgms^-1",delta_p)
//The answer provided in the textbook is wrong.
```

Scilab code Exa 12.4 Potential Well

```
clc;
clear;
L=0.5*10^-9 //width in m
m=9.1*10^-31 //mass in kg
V_0=15*1.6*10^-19 //height of the potential well in J
h=6.63*10^-34 //Plancks constant in J-s

//calculation
n_max=(4*L*sqrt(m*V_0))/h

mprintf("The maximum quantum number possible is %d",n_max)
```

Scilab code Exa 12.5 Penetration distance of electron

```
clc;
clear;
m=9.1*10^-31 //mass in kg
```

```
h=6.63*10^-34 //Plancks constant in J-s
v=10^5 //velocity in m/s

//calculation
E=(m*v^2)/2 //in J
gam=(2*%pi*sqrt(2*m*E))/h //in m^-1
d=1/(gam*10^-9) //dividing by 10^-9 to convert from m to nm

mprintf("The penetration distance of the electron is = %1.2f nm",d)
```

Scilab code Exa 12.6 `Tunneling probabilty`

```
clc;
clear;
h=6.63*10^-34 //Plancks constant in J-s
m=9.1*10^-31 //mass in kg
E=2 //energy in eV
V_0=20 //height of potential barrier in eV
alpha=0.3*10^-9 //width of potental barrier in m
e=1.6*10^-19 //charge in C

//calculation
Gamma=(2*%pi*(sqrt(2*m*(V_0-E)))*e)/h //in m^-1
T=((16*E*(V_0-E)/V_0^2)*exp(-2*(Gamma)*alpha))
mprintf("The tunneling probability is = %1.2e",T)
//The answer provided in the textbook is wrong.
```