

Scilab Textbook Companion for
Physics For Engineers
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Scilab numbering policy used in this document and the relation to the above book.

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

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Chapter 1

Vibrations and Resonance

Scilab code Exa 1.1 Damped Oscillations

```
1  clc ;
2  clear ;
3  m=100*10^-3 //flat disc mass in kg
4  t=60 //time period of oscillation in sec
5  omega=10 //frequency in Hz
6
7  //Calculation
8  damp_omega=log(2)/60 //amplitude of damped
   oscillator for A/C = 1/2 in rad/s
9  c= 2*m*damp_omega
10 tau= 1/damp_omega
11
12 mprintf(" Resistive force = %0.2e newton-s/meter \n",
   c)
13 mprintf(" Relaxation time = %2.2f s",tau) //The
   answer provided in the textbook is wrong.
```

Scilab code Exa 1.2 Damped Oscillations

```
1  clc ;
2  clear ;
3  K=10 //Spring constant in N/m
4  m=0.1 //Mass in kg
5
6  //calculation
7  // for (a)
8  damp_omega=-1/-100
9  c=m*2*damp_omega
10
11 //for (b)
12 omega_n=sqrt(K/m)
13
14 //for (c)
15 eta=damp_omega/omega_n
16 Q=1/(2*eta)
17 omega_d=omega_n*sqrt(1-eta^2) //in radian/s
18
19 //for (d)
20 fract_change=0.5*(eta^2) //fractional change in
    frequency
21 percent_change=fract_change*(10^2)
22
23 mprintf("\n(a)\n")
24 mprintf("Resistive force constant c = %.0e newton-s/
    meter\n",c)
25 mprintf("(b)\n")
26 mprintf("Natural angular frequency omega_n = %d rad/
    s\n",omega_n)
27 mprintf("(c)\n")
```

```

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

```

Scilab code Exa 1.3 Harmonic oscillations

```

1  clc ;
2  clear ;
3  m=0.1 // mass in kg
4  K=100 //spring constant in N/m
5  c=1 //resistive force in Nsm-1
6  F0=2 //force in N
7  omega=50 //frequency in rad/s
8
9  //calculation
10
11 omega_n=sqrt(K/m) //in rad/s
12 r=omega/omega_n
13 delta_st=F0/K //in m
14 damp_ratio=c/(2*m*omega_n)
15 A=delta_st/(sqrt((1-r2)2+(2*r*damp_ratio)2))
16 tan_phi=(2*r*damp_ratio)/(1-r2) //in degree
17 phi=180+atand(tan_phi) //converting degree to
    positive form
18
19 mprintf("Amplitude of oscillation = %1.2e m\n",A)
20 mprintf("Phase relative to the applied force is = %1
    .1f degree",phi)
21 //The answers vary due to round of errors

```

Scilab code Exa 1.4 Series circuit

```
1  clc;
2  clear;
3  omega=500 //frequency in radian/s
4  L=0.08 //inductance in H
5  R=15 //resistance in ohm
6  C=30*10^-6 //capacity in F
7
8  //calculation
9
10 L_omega=L*omega //in ohm
11 C_omega=1/(C*omega) //in ohm
12 tan_phi=(L_omega-C_omega)/R //in degrees
13 phi=atand(tan_phi)
14
15 mprintf("The current leads the applied voltage by =
    %2.2f degree",-phi)
16 //The answers vary due to round off error
```

Scilab code Exa 1.5 Series circuit

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

```

6 E0=141.4 //electric field in V
7 I0=5 //current in A
8
9 //calculation
10 Z1=sqrt(2) //first equation for impedance Z
11 Z2=E0/I0//second equation for impedance Z
12 R=Z2/Z1 //resistance in ohm
13 L_omega=L*omega //in ohm
14 C=(1/((L_omega-R)*omega)/10^-6) //converting from F
    to micro F dividing by 10^-6
15
16
17 mprintf(" Resistance is = %d ohm\n",R) //The answers
    vary due to round off error
18 mprintf(" Capacitance is = %2.1f micro F\n",C)

```

Scilab code Exa 1.6 Series RLC circuit

```

1 clc;
2 clear;
3 R=50 //resistance in ohm
4 C=25 //capacitance in micro-F
5 L=0.15 //inductance in H
6 V=230 //voltage in Volts
7 f=50 //frequency in Hz
8
9 //calculation
10 XL=2*%pi*f*L //in ohm
11 XC=(10^6)/(2*%pi*f*C) //in ohm
12 X=XL-XC //in ohm
13 Z=sqrt(R^2+X^2)
14 I=V/Z
15 pf=R/Z

```

```

16 power_consumed=V*I*pf
17
18 mprintf("(i) Impedance = %2.1f ohm\n",Z) //The
    answers vary due to round off error
19 mprintf("(ii) Current = %1.2f A\n",I) //The answers
    vary due to round off error
20 mprintf("(iii) Power Factor = %1.2f (Lead)\n",pf)
21 mprintf("(iv) Power Consumed = %d W",power_consumed)
    //The answers vary due to round off error

```

Scilab code Exa 1.7 Insulated wire

```

1 clc;
2 clear;
3 R=8 //resistance in ohm
4 L=0.03 //inductance in H
5 V=240 //voltage in Volts
6 f=50 //frequency in Hz
7 reactance_RLC=9.42 //reactance of total RLC circuit
    in ohm in case(2)
8
9 //calculation
10 //for (1)
11 X_L=2*%pi*f*L // inductive reactance in ohm
12 Z=sqrt(R^2+X_L^2) //in ohm
13 I=V/Z // current in A
14 P=I^2*R // Power in Watt
15 pf=R/Z //power factor is the ratio of R/Z
16
17 //for (2)
18 reactance_C=2*reactance_RLC //capacitive reactance
    in ohm
19 omega=2*%pi*f //angular frequency in rad/s

```

```

20 C=(1/(omega*reactance_C)/10^-6) //converting from F
    to micro F dividing by 10^-6
21
22 mprintf("(i) Impedance = %2.1f ohm\n",Z) //The answer
    varies due to round off error
23 mprintf("(ii) Current = %1.2f A\n",I) //The answers
    varies due to round off error
24 mprintf("(iii) Power Factor = %1.2f (lag)\n",pf)
25 mprintf("(iv) Power Consumed = %d W\n",P) //The
    provided in the textbook is wrong.
26 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

```

1  clc;
2  clear;
3  C= 4*10^-6 // capacitance in F
4  L=0.25 // inductance in H
5  R=50 //resistance in ohm
6
7  //calculation
8
9  F0=1/(2*pi)*sqrt(1/(L*C)-(R^2/L^2))
10
11 mprintf("The frequency of resonance = %f Hz",F0)
12 //The answer varies due to round off error

```

Scilab code Exa 1.9 Insulated wire

```

1  clc;
2  clear;
3  R=30 // resistance in ohm
4  L= 20*10^-3 //inductance in H
5  f=1000/%pi //frequency in Hz
6  V=25 //in volt
7
8  //calculation
9  // for (a)
10 inductance_l=2*%pi*f*L //in ohm
11 Z=sqrt(R^2+inductance_l^2) //in ohm
12 C=L/Z^2
13
14 mprintf("\n(a) The capacitance of the circuit is %d
        microF\n",C/10^-6) //converting from F to mF
        dividing by 10^-6
15
16 //for (b)
17
18 dynamic_imp=L/(C*R) //in ohm
19 I_min=V/dynamic_imp
20
21 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

```
1 clc ;
2 clear ;
3 V=7500 //volume in m^3
4 T=1.2 //time in seconds
5
6 //calculations
7 A=(0.162*V)/T
8
9 mprintf("Total absorption in hall = %0.1f sq-m
    sabine",A)
```

Scilab code Exa 2.2 Reverberation time of a hall

```
1 clc ;
2 clear ;
```

```

3 V=1500 //volume of hall in m^3
4 Area_plastered_wall=112 //in m^2
5 Area_woodem_floor=130 //in m^2
6 Area_plastered_ceiling=170 //in m^2
7 Area_wooden_doors=20 //in m^2
8 Area_cushioned_chairs=120 //in m^2
9 Area_Audience=120 //in m^2
10
11
12 //Coefficient of Absorption (c)
13 c_plastered_wall=0.03
14 c_woodem_floor=0.06
15 c_plastered_ceiling=0.04
16 c_wooden_doors=0.06
17 c_cushioned_chairs=0.50
18 c_Audience=0.4367
19
20
21
22 //calculation
23 Abs_plastered_wall=Area_plastered_wall*
    c_plastered_wall //in m^2 sabine
24 Abs_wooden_floor=Area_woodem_floor*c_woodem_floor //
    in m^2 sabine
25 Abs_plastered_ceiling=Area_plastered_ceiling*
    c_plastered_ceiling //in m^2 sabine
26 Abs_wooden_doors=Area_wooden_doors*c_wooden_doors //
    in m^2 sabine
27 Abs_cushioned_chairs=Area_cushioned_chairs*
    c_cushioned_chairs //in m^2 sabine
28 Total_absorption1 = Abs_plastered_wall+
    Abs_wooden_floor+Abs_plastered_ceiling+
    Abs_wooden_doors+Abs_cushioned_chairs //in m^2
    sabine
29
30 //Case (i)
31 T1=(0.162*V)/Total_absorption1
32

```

```

33 //case (ii)
34 Abs_Audience=Area_Audience*c_Audience //in m^2
    sabine when hall at full capacity
35 Total_absorption2 = Abs_plastered_wall+
    Abs_wooden_floor+Abs_plastered_ceiling+
    Abs_wooden_doors+Abs_cushioned_chairs+
    Abs_Audience //in m^2 sabine
36 T2=(0.162*V)/Total_absorption2
37
38 mprintf("Reverberation time when hall empty = %1.2f s
    \n",T1)
39 mprintf("Reverberation 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

```

1  clc;
2  clear;
3  l=20 //room length in m
4  b=15 //room breadth in m
5  h=8 //room height in m
6  capacity=200 //number of seats in hall
7  Absorption_air=0.012 // per m^3
8
9  //Coefficient of Absorption (c)
10 c_wall=0.09
11 c_ceiling=0.04
12 c_floor=0.06 //Value given in the sum is wrong which
    is 0.60
13 c_seat=0.64
14
15

```

```

16 //calculation
17 A1=2*((b*h)+(l*h))*c_wall //in m^2
18 A2=(l*b)*c_ceiling //in m^2
19 A3=(l*b)*c_floor //in m^2
20 A4=(capacity/2)*(1-c_seat) //in m^2
21 A5=(capacity/2)*(c_seat) //in m^2
22 Volume=l*b*h //in m^3
23 A6=Volume*Absorption_air
24 T=A1+A2+A3+A4+A5+A6 //Total absorptionin m^2
25 T=0.161*(Volume/(T+A6))
26
27 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

```
1  clc;
2  clear;
3  d=0.08*10^-2 //distance between parallel slits in m
4  Beta=6*10^-4 //fringe width in m
5  v=8*10^11*10^3 //frequency of light in Hz
6  c=3*10^8 //velocity of light in m/s
7
8  //calculation
9  lambda=c/v //wavelength in m
10 D=(Beta*d)/lambda
11
12 mprintf("The distance of the screen from the slits
    should be = %1.2f m",D)
```

Scilab code Exa 4.2 Youngs double slit experiment

```

1  clc;
2  clear;
3  lambda_1=4200*10^-10 //wavelength in m in first case
4  Beta_1=0.46*10^-2 //fringe width in m in first case
5  Beta_2=0.64*10^-2 //fringe width in m in second case
6
7  //calculation
8  lambda_2=(lambda_1*2*Beta_1)/Beta_2 //dividing first
   case by second
9  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

```

1  clc;
2  clear;
3  D=0.82 //distance between the source and the screen
   in m
4  B=0.02 //distance between the source and the biprism
   in m
5  lambda=6900*10^-10 //wavelength in m
6  myu=1.5 //refractive index
7  alpha=%pi/180 //refracting angle in radian
8
9  //calculation
10 d=2*(myu-1)*alpha*B //distance between sources in m
11 Beta=(lambda*D)/d
12
13 mprintf("The fringe width is = %1.3e m",Beta)

```

Scilab code Exa 4.4 Fresnels biprism

```
1  clc;
2  clear;
3  D=1 //distance between the source and the screen in
      m
4  lambda=5893*10^-10 //wavelength in m
5  d1=4.05*10^-3 //distance between two images of the
      slit in m in first case
6  d2=2.90*10^-3 //distance between two images of the
      slit in m in second case
7
8  //calculation
9  d=sqrt(d1*d2) //distance between the slits in m
10 Beta=(lambda*D)/d
11
12 mprintf("The distance between interference fringes
      is %1.2e m",Beta)
13 //The answer provided in the textbook is wrong.
```

Scilab code Exa 4.5 Biprism experiment

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

```

6 D=1 // distance between the slit and the images in m
7 Beta=0.0195*10^-2 //fringe width in m
8
9 //calculation
10 d=(I*u)/v
11 lambda=(Beta*d)/D
12
13 mprintf("The wavelength of light used is = %e m or
          5850*10^-10 m.",lambda)

```

Scilab code Exa 4.6 Youngs double slit experiment

```

1 clc;
2 clear;
3 Y1=1*10^-3 //distance of the point from the screen
           in m for first case
4 D=1 //distance between the slit and the screen in m
5 d=1*10^-3 //distance between the slits in m
6 lambda=5893*10^-10 //wavelength in m
7 phase_diff2=%pi/2 //phase difference when intensity
           is half the maximum
8
9 //calculation
10 delta_1=(Y1*d)/D //path difference in m
11 phase_diff=(2*%pi*delta_1)/lambda //phase difference
           in radian
12 Ratio=cos(phase_diff/2)^2
13 mprintf("\n\nThe ratio of intensity with the central
           maximum is = %1.4f\n",Ratio)
14 //The answer provided in the textbook is wrong.
15
16 delta_2=(phase_diff2*lambda)/2*%pi
17 Y2=(delta_2*D)/d

```



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

Scilab code Exa 4.7 Biprism experiment

```
1 clc;
2 clear;
3 d1=0.42*10^-3 //distance between images obtained at
    position 1 in m
4 d2=1.21*10^-3 //distance between images obtained at
    position 2 in m
5 Beta_1=0.4*10^-3 //bandwidth in m at position 1
6 Beta_2=0.5*10^-3 //bandwidth in m at position 2
7 D2_minus_D1=0.60 //displacement in position in m
8
9 //calculation
10
11 d=sqrt(d1*d2) //distance between sources in m
12 lambda=(d*(Beta_2-Beta_1))/D2_minus_D1
13
14 mprintf("The wavelength of the source is = %1.3e m",
    lambda)
15 //The answer provided in the textbook is wrong.
```

Scilab code Exa 4.8 Biprism experiment

```
1 clc;
2 clear;
```

```

3 myu=1.45 //refractive index
4 t1=5*10^-6 //thickness of the sheet in m
5 Beta=0.3*10^-3 //bandwidth in m
6 lambda=5860*10^-10 //wavelength in m
7
8 //calculation
9 X_0=((myu-1)*t1*Beta)/lambda //shift of the central
   band in m
10 t2=(X_0*lambda)/(Beta*(myu-1))
11
12 mprintf("The thickness of the mica sheet is = %1.3e
   m.",t2)
13 //The answer provided in the textbook is wrong.

```

Scilab code Exa 4.9 Biprism experiment

```

1 clc;
2 clear;
3 Beta=0.2*10^-3 //bandwidth in m
4 myu=1.5 //refractive index of the biprism
5 myu_0=1.3 //refractive index of the liquid
6
7 //calculation
8 Beta_0=(Beta*(myu-1))/(myu-my_0)
9 mprintf("The bandwidth when the setup is immersed in
   liquid is = %1.0e m",Beta_0)

```

Scilab code Exa 4.10 Biprism experiment

```

1  clc;
2  clear;
3  lambda1=6360 //wavelength in Angstrom
4  Beta2_by_Beta1=7.5/8 //Ratio of the fringes widths
5  Beta1_by_Beta2=7.5/8.5 //Ratio of the fringes widths
6
7  //calculation
8  //case (i)
9  lambda2=Beta2_by_Beta1*lambda1
10 mprintf("The wavelength 8th bright band is = %4.1f
    A\n",lambda2)
11
12 //case (ii)
13 lambda2=Beta1_by_Beta2*lambda1
14 mprintf("The wavelength 9th dark band is = %4.1f A"
    ,lambda2)

```

Scilab code Exa 4.11 Double slit experiment

```

1  clc;
2  clear;
3  lambda=4800*10^-10 //wavelength in m
4  n=5 //position occupied by the central bright fringe
5  myu=1.4 //refractive index of glass covering slit 1
6  myu_0=1.7 ////refractive index of glass covering
    slit 2
7
8  //calculation
9  t=(n*lambda)/(myu_0-myu)
10
11 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

```
1  clc;
2  clear;
3  n1=62 //no of fringes observed
4  lambda_1=5893 //wavelength of sodium light in
   Angstrom
5  lambda_2=5461 //wavelength of mercury lamp in
   Angstrom
6
7  //calculation
8  n2=(n1*lambda_1)/lambda_2
9
10 mprintf("The fringes obtained when sodium lamp is
   replaced by a mercury lamp is = %d",n2)
11 //The answer varies due to round off error.
```

Scilab code Exa 4.13 Refractive index of oil

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

```

8
9 //calculation
10 d=vol/area //thickness of the film of oil in cm
11 myu=(n*lambda)/(2*d*cosd(0))
12
13 mprintf("The refractive index of oil is = %1.3f",myu
)

```

Scilab code Exa 4.14 Reflection from soap film

```

1 clc;
2 clear;
3 i=35 //angle of incidence in degree
4 myu=1.33 //refractive index
5 d=5*10^-5 //thickness of the soap film in cm
6 n1=1 //for first order
7 n2=2 //for second order
8 n3=3 //for third order
9 n4=4 //for fourth order
10
11 //calculation
12 r=asind(sind(i)/myu) //angle of refraction in degree
13
14 //case(1) for first order
15 lambda_1=(2*myu*d*cosd(r))/n1
16
17 //case(2) for second order
18 lambda_2=(2*myu*d*cosd(r))/n2
19
20 //case(3) for third order
21 lambda_3=(2*myu*d*cosd(r))/n3
22
23 //case(14) for fourth order

```

```

24 lambda_4=(2*myu*d*cosd(r))/n4
25
26
27 mprintf("\n The wavelength of light for first order
    is = %1.2e cm and it lies in the infrared region\
n",lambda_1)
28 mprintf("\n The wavelength of light for second order
    is = %1.1e cm and it lies in the visible region\
n",lambda_2)
29 mprintf("\n The wavelength of light for third order
    is = %1.1e cm and it lies in the visible region\
n",lambda_3)
30 mprintf("\n The wavelength of light for fourth order
    is = %1.1e cm and it lies in the ultravoilet(
    invisible) region\n",lambda_4)
31 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

```

1  clc;
2  clear;
3  d=0.05*10^-3 //diameter of the wire in m
4  D=15 //distance between the glass plates and the
    edge in cm
5  lambda=6000*10^-10 //wavelength in m
6
7
8  //calculation
9  alpha=d/D //wedge angle in radian
10 Beta=lambda/(2*alpha)
11

```

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

Scilab code Exa 4.16 Wedge shaped air film

```
1 clc;  
2 clear;  
3 alpha=0.01 //wedge angle in radian  
4 lambda=6000*10^-10 //wavelength in m  
5 n=10 //the fringe observed  
6  
7 //calculation  
8 x=((2*n-1)*lambda)/(4*alpha)  
9  
10 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

```
1 clc;  
2 clear;  
3 f=400 //focal length of lens in cm  
4 myu=1.50 //refractive index  
5 lambda=5460*10^-6 //wavelength in cm  
6 n=5 //fifth bright ring  
7  
8 //calculation  
9 R=(myu-1)*2*f //radius of curvature in cm  
10
```

```

11 D5=sqrt(2*((2*n)-1)*lambda*R)
12
13 mprintf("The diameter of the fifth bright ring is =
    %1.2f cm",D5)
14 //The answer provided in the textbook is wrong.

```

Scilab code Exa 4.18 Newtons Rings experiment

```

1 clc;
2 clear;
3 D_4=0.4 //diameter of the 4th dark ring in cm
4 D_12=0.7 //diameter of the 12th dark ring in cm
5
6 //calculation
7 D_20=sqrt(2*((0.7^2)-(0.4^2))+0.4^2)
8 mprintf("The diameter of the 20th dark ring is = %1
    .3f cm",D_20)

```

Scilab code Exa 4.19 Newtons Rings experiment

```

1 clc;
2 clear;
3 D_10=1.40 //diameter of the 10th ring in air in cm
4 D_10_liquid=1.27 //diameter of the 10th ring in
    liquid in cm
5
6 //calculation
7 myu=D_10^2/D_10_liquid^2

```



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

Scilab code Exa 4.20 Newtons Rings experiment

```
1 clc;
2 clear;
3 R=100 //radius of curvature in cm
4 D_5=0.3 //diameter of the 5th dark ring in cm
5 D_25=0.8 //diameter of the 25th dark ring in cm
6 n5=5 //fifth dark ring
7 n25=25 //twenty fifth ring
8
9 //calculation
10 p = n25 - n5 //difference in no of fringes
11 lambda=((D_25^2)-(D_5^2))/(4*p*R)
12
13 mprintf("The wavelength of light used is = %1.2e cm"
   ,lambda)
14 //The answer provided in the textbook is wrong.
```

Scilab code Exa 4.21 Michelsons interferometer

```
1 clc;
2 clear;
3 disp_X=0.05896*10^-3 //displacement of mirror in m
4 n=200 //no of fringes
5
6 //calculation
```

```

7 lambda=(2*disp_X)/n
8
9 mprintf("The wavelength of the light is = %1.3e m",
    lambda)
10 //The answer provided in the textbook is wrong.

```

Scilab code Exa 4.22 Michelsons interferometer

```

1 clc;
2 clear;
3 lambda_ave=5893*10^-10 //mean wavelength in m
4 X2_minus_X1=0.2945*10^-3 //displacement of mirror in
    m
5
6 //calculation
7 lambda1_minus_lambda2=lambda_ave^2/(2*X2_minus_X1)
8 mprintf("The difference in wavelengths is = %1.3e m"
    ,lambda1_minus_lambda2)
9 //The answer varies due to round off error.

```

Scilab code Exa 4.23 Michelsons interferometer

```

1 clc;
2 clear;
3 myu=1.5 //refractive index of glass plate
4 n=30 //no of fringes
5 d=0.018 //thickness of the plate in mm
6
7 //calculation

```

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

Scilab code Exa 4.24 Michelsons interferometer

```
1 clc;
2 clear;
3 t=3 //thickness of air cell in cm
4 delta_myu=0.000230 //difference in pressure
5 lambda=5.46*10^-5 //wavelength in cm
6
7 //calculation
8 change_in_path=t*delta_myu // change in one way path
    in cm
9 n=(2*change_in_path)/lambda
10 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

```
1 clc ;
2 clear ;
3 k=2
4 lambda=5*10^-5 //wavelength in cm
5 theta=30 //angle in degrees
6
7 //calculations
8 e=(k*lambda)/sind(theta) //in cm
9 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

```
1 clc ;
2 clear ;
```

```

3 lambda=5*10^-5 //wavelength in cm
4 e=1/6000 //No. of lines per centimeter on the
   grating surface
5
6 //calculation
7 //1st order
8 theta_1= asind(lambda/e) //angle in degree
9
10 //3rd order
11 theta_3= asind((3*lambda)/e) //angle in degree
12
13 angle_of_deviation = theta_3 - theta_1
14
15 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

```

1 clc;
2 clear;
3 lambda=5890*10^-8 //wavelength in cm
4 k=2
5 d_lambda=(5896 - 5890)*10^-8 //grating width in cm
6 d=2.5 //grating width in cm
7
8 //calculation
9 N=lambda/(k*d_lambda) //No. of grating lines
10 No_of_lines = N/d
11
12 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

```
1  clc;
2  clear;
3  lambda=5890*10^-8 //wavelength in cm
4  k1=1 //first order of wavelength
5  k2=2 //second order of wavelength
6  N=425 // grating lines per cm
7  d_lambda=(5896 - 5890)*10^-8 //grating width in cm
8  d=2 //grating width in cm
9
10 //calculation
11 Total_lines = N*2 //Total no. of lines on the
    grating
12
13 //for the first order
14 N1=ceil(lambda/(k1*d_lambda)) //No. of grating lines
15
16 //for the second order
17 N2=ceil(lambda/(k2*d_lambda)) //No. of grating lines
18
19 if(Total_lines>N1) then
20     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)
21 else
22     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)
23 end
24
25 if(Total_lines>N2) then
26     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)
27 else
28     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)
29 end

```

Scilab code Exa 5.5 Angle of separation between lines

```

1  clc;
2  clear;
3  lambda1=5016*10^-8 //wavelength in cm
4  lambda2=5048*10^-8 //wavelength in cm
5  N=15000 //lines per inch
6  k=2
7
8  //calculation
9  e=2.54/N //in cm
10 theta1_degrees= floor(asin((2*lambda1)/e)*(180/%pi))
    //degrees part of angle
11 theta1_minutes=ceil((asin((2*lambda1)/e)*(180/%pi)-
    theta1_degrees)*60) //minutes part of angle
12 theta2_degrees = floor(asin((2*lambda2)/e)*(180/%pi)
    ) //degrees part of angle
13 theta2_minutes=ceil((asin((2*lambda2)/e)*(180/%pi)-

```

```

        theta2_degrees)*60) //minutes part of angle
14
15
16 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

```

1  clc;
2  clear;
3  lambda=5000*10^-8 //wavelength in cm
4  N=15000 //lines per inch
5  k=3
6  e=1/4000 //in cm
7
8  //calculation
9  sin_theta = (k*lambda)/e //in radian
10 cos_theta = sqrt(1-sin_theta^2) // in radian
11 dispersive_power = k/(e*cos_theta)
12
13 printf("Dispersive power of the grating in third
        order spectrum = %d",dispersive_power)

```

Scilab code Exa 5.7 Highest order spectrum

```

1  clc;
2  clear;
3  lambda=6000*10^-8 //wavelength in cm

```



```

4 N=5000 //lines per cm
5 k=3
6 e=1/5000 //in cm
7 sin_theta=1 //angle in radian
8
9 //calculation
10 k=(e*sin_theta)/lambda
11
12 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

```

1 clc;
2 clear;
3 theta=10 //angle in degree
4 d_theta=3 //angle in degree
5 d_lambda=5*10^-9 //wavelength in cm
6 k=2
7
8 //calculation
9 lambda=(sind(theta)*d_lambda)/(cosd(theta)*(d_theta
    /(60*60))*(%pi/180)) // wavelength in cm
10 N=lambda/(d_lambda*k) //number of lines
11 Ne = (N*k*lambda)/sind(theta)
12
13 printf("Minimum grating width required = %1.1f cm",
    Ne)

```

Scilab code Exa 5.9 The grating element

```
1  clc ;
2  clear ;
3  sin_theta1=0.2 //angle in radian
4  sin_theta2=0.3 // angle in radian
5  lambda = 5000*10^-9 //wavelength in cm
6  d=2.5 //width of the grating surface in cm
7
8  //calculations
9  e=lambda/(sin_theta2-sin_theta1) //in cm
10 N=d/e //number or rulings
11 Rp=2*N
12
13 printf(" Resolving power = %d",ceil(Rp))
```

Chapter 6

Polarization of light and Photoelasticity

Scilab code Exa 6.1 Polarizing angle

```
1 clc ;  
2 clear ;  
3 myu=1.5 // refractive index of glass  
4  
5 // calculation  
6 i_p=atand(myu)  
7  
8  
9 mprintf("The polarizing angle is = %1.2f degree",i_p  
    )
```

Scilab code Exa 6.2 Quarter wave plate

```

1  clc;
2  clear;
3  lambda=6000*10-10 //wavelength in m
4  myu_0=1.554 //refractive index
5  myu_e=1.544 //refractive index
6
7  //calculation
8  d=lambda/(4*(myu_0-myu_e))
9
10 mprintf("The thickness of the quarter wave plate is
    = %1.1e m",d)

```

Scilab code Exa 6.3 Quarter wave plate

```

1  clc;
2  clear;
3  d=12.5*10-6 //thickness of the quarter wave plate
    in m
4  myu_diff=0.01 //difference in refractive indices
5
6  //calculation
7
8  lambda=d*4*(myu_diff)
9  mprintf("The wavelength is = %1.0e m",lambda)

```

Scilab code Exa 6.4 Quartz plate

```

1  clc;
2  clear;

```

```
3 myu_e=1.553 //refractive index
4 myu_0=1.542 //refractive index
5 lambda=5.5*10^-5//wavelength in m
6
7 //calculation for minimum thickness i.e half wave
  plate
8 d=lambda/(2*(myu_e-myu_0))
9
10 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

```
1  clc;
2  clear;
3  P=10^-3 //power in watt
4  A=3*10^-6 //cross section area in m^2
5  n=1 //refractive index
6  c=3*10^8 //velocity of light in m/s
7  myu=4*10^-7 //vaccum permittivity
8
9  //calculation
10 I=P/A // Intensity in W/m^2s
11 E_0=sqrt((2*c*myu*I)/n)
12 mprintf("The electric field of the laser beam is = %d
           V/m",E_0)
13 //The answer provided in the textbook is wrong
```

Scilab code Exa 7.2 Electric field of a bulb

```
1  clc ;
2  clear ;
3  P=10 //power in watt
4  d=10 //distance from the source in m
5  n=1 //refractive index
6  c=3*10^8 //velocity of light in m/s
7  myu_0=4*10^-7 //vaccum permittivity
8
9  //calculation
10 I=P/(4*%pi*d^2) //intensity in W/m^2
11 E_0=sqrt(2*c*myu_0*I)/n
12
13 mprintf("The electric field of the bulb = %f V/m",
    E_0)
14 //The answer given in the textbook is wrong.
```

Scilab code Exa 7.3 Electric field intensity

```
1  clc ;
2  clear ;
3  P=10^-3 //power in watt
4  r=6*10^-3 //distance from the source in m
5  c=3*10^8 // velocity of light in m/s
6  myu_0=4*10^-7 //refractive index
7  n=1
8
9  //calculation
10
11 I=P/(%pi*(r^2)) //intensity in W/m^2
12 E=sqrt((2*c*myu_0*I)/n)
13 mprintf("The electric field at a point = %1.1e volt/
```

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

Scilab code Exa 7.4 Ratio of populations

```
1  clc;
2  clear;
3  lambda=694.3*10^-9 //wavelength in m
4  K_b=1.38*10^-23 //Boltzmann constant J/K
5  T=300 //Temperature in K
6  h=6.63*10^-34 //Plancks constant in J-s
7  c=3*10^8 //velocity of light in m/s
8
9  //calculation
10
11 N1_by_N2=exp(-(h*c)/(lambda*K_b*T))
12
13 mprintf("The ratio of population of two energy
    levels N1/N2 is = %1.2e",N1_by_N2)
14 //The answer provided in the textbook is wrong.
```

Scilab code Exa 7.5 Ratio of populations

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



```

7 c=3*10^8 //velocity of light in m/s
8
9 //calculation
10
11 lambda=(h*c)/(30*K_b*T)
12
13 mprintf("The wavelength of the radiation emitted is
    = %e m",lambda)
14 //The answer given in the textbook is wrong.

```

Scilab code Exa 7.6 Ratio of stimulated to spontaneous emission

```

1 clc;
2 clear;
3 lambda=694.3*10^-9 //wavelength in m
4 K_b=1.38*10^-23 //Boltzmann constant J/K
5 T=300 //Temperature in K
6 h=6.63*10^-34 //Plancks constant in J-s
7 c=3*10^8 //velocity of light in m/s
8
9 //calculation
10 Exp=(h*c)/(lambda*K_b*T) //exponential term of the
    formula
11 R=1/(exp(Exp)-1)
12
13 mprintf("The ratio of stimulated emission to
    spontaneoius emission is = %e",R)
14 //The answer provided in the textbook is wrong.

```

Scilab code Exa 7.7 No of photons emitted

```
1  clc ;
2  clear ;
3  P=1 //power in W
4  lambda=694.3*10^-9 //wavelength in m
5  h=6.63*10^-34 //Plancks constant in J-s
6  c=3*10^8 //velocity of light in m/s
7
8  //calculation
9  n=(P*lambda)/(h*c)
10
11 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

```
1  clc;
2  clear;
3  d=60 // diameter in micrometer
4  n1=1.48 //core refractive index
5  n2=1.41 //cladding refractive index
6  lambda=0.8 //wavelength of light source in
   micrometer
7
8  //calculation
9
10 NA=sqrt(n1^2-n2^2) //numerical aperture
11 V=(%pi*d*NA)/lambda //normalized frequency in cycles
   /sample
12 M=V^2/2
13
14 mprintf("The no of modes propogating in the fibre
   are %e",M)
15 //The answer provided in the textbook is wrong.
```

Scilab code Exa 9.2 Attenuation of light

```
1  clc;
2  clear;
3  alpha=2.2 //attenuation of light in dB/km
4  L1=2 //distance in km
5  L2=6 //distance in km
6
7  //calculation
8  //Case(a):when distance L = 2km
9  It_by_IO_1=10^-((alpha*L1)/10)
10
11 //Case(b):when distance L = 6km
12 It_by_IO_2=10^-((alpha*L2)/10)
13
14 mprintf("\nThe fraction of intial intensity that
    will remain after 2km is = %1.3f\n",It_by_IO_1)
    //The answer varies due to round off error.
15 mprintf("\nThe fraction of intial intensity that
    will remain after 6km is = %1.3f",It_by_IO_2) //
    The answer varies due to round off error.
```

Scilab code Exa 9.3 Angle of acceptance

```
1  clc;
2  clear;
3  n1=1.48 //core refractive index
4  delta=0.05 //fractional refractive index
```

```

5
6 //calculation
7 NA=n1*sqrt(2*delta) //numerical aperture
8 i_a=asind(NA)
9
10 mprintf("\nThe numerical aperture is = %1.3f\n",NA)
11 mprintf("The acceptance angle is = %2.1f degree.",
    i_a)

```

Scilab code Exa 9.4 Angle of acceptance

```

1 clc;
2 clear;
3 n1=1.45 //refractive index of core
4 n2=1.40 //refractive index of cladding
5
6 //calculation
7 NA=sqrt(n1^2-n2^2)
8 mprintf("\nThe numerical aperture is = %1.4f.\n",NA)
9
10 i_a=asind(NA)
11 mprintf("The acceptance angle is = %d degree.",i_a)

```

Scilab code Exa 9.5 Loss of specification

```

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

```

```

5 I_t=8.6*10^-6 //output power in Watt
6
7 //calculation
8 alpha=- (10/L)*log10(I_0/I_t)
9
10 mprintf("The loss specification of the fibre is = -
    %1.1f dB/km",alpha)
11 //The answer varies dur to round off error.

```

Scilab code Exa 9.6 Core Cladding interface

```

1 clc;
2 clear;
3 n1=1.5 //core refractive index
4 delta=1.8*10^-2 //fractional refractive index
5 ratio=0.982 //ratio of cladding to core refractive
    index
6 c=3*10^8 //velocity of light in m/s
7
8 //calculation
9 NA=n1*sqrt(2*delta) //numerical aperture
10 mprintf("\nThe numerical aperture is = %1.3f\n",NA)
11
12 i_a=asind(0.285)
13 mprintf("The acceptance angle is = %2.1f degree\n",
    i_a)
14
15 i_c=asind(ratio)
16 mprintf("The critical angle at the core cladding
    interface is = %2.1f degree\n",i_c)
17
18 v_core=c/n1
19 mprintf("The velocity of light in the core is = %1.0

```

```
    e m/s\n",v_core)
20
21 v_clad=c/(ratio*n1)
22 mprintf("The velocity of light in the cladding is =
    %1.2e m/s",v_clad)
```

Scilab code Exa 9.7 Fiber length

```
1 clc;
2 clear;
3 alpha=-0.5 //attenuation in dB/km
4 I_t=2*10^-6 //input power in W
5 I_o=1.5*10^-3 //output power in W
6
7 //calculation
8 L=-(10/0.5)*log10(I_t/I_o)
9 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

```
1  clc ;
2  clear ;
3  T1=6000 //temperature of the sun in K
4  E1_by_E2=17000 //ratio of luminosity of sun to the
    star
5
6  //calculation
7
8  T2=T1*E1_by_E2^(1/4)
9  mprintf("The temperature of the star is = %d K",T2)
10 //Answer varies due to round off error
```

Scilab code Exa 10.2 Energy radiated per minute


```

1  clc;
2  clear;
3  e=0.85 //emissivity
4  T=2000 //Temperature in K
5  A=5*10^-5 //surface area in m^2
6  t=60 //time in s
7  sigma=5.7*10^-8 //Stefan-Boltzmann Constant in J/m^2
      sK^4
8
9  //calculation
10 Q=e*sigma*T^4*A*t
11 mprintf("The energy radiated per unit area per sec
      is = %d Joules.",Q)
12 //The answer varies due to round off error.

```

Scilab code Exa 10.3 Work function of a metal

```

1  clc;
2  clear;
3  h=4.136*10^-15 //Plancks constant in eV
4  c=3*10^8 //velocity of light in m/s
5  R=1.097*10^7 //Rydberg constant m^-1
6  lambda1= 900 //wavelength in nm
7  T1_by_T2=1/3 //Ratio of temperature T1 to T2
8  n1=2 //energy level of atom
9  n2=3 //energy level of atom
10
11 //calculation
12
13 lambda2=(lambda1*T1_by_T2)//wavelength in nm
14 E=(h*c)/(lambda2*10^-9) //Energy of incident photon
      in eV
15 Ex=R*h*c*((1/n1^2)-(1/n2^2)) //Excitation energy in

```

```

    eV
16 W=E-Ex
17
18 mprintf("The work function of the metal is = %1.2f
    eV",W)

```

Scilab code Exa 10.4 Temperature of the sun

```

1 clc;
2 clear;
3 S=1.4*10^3 //rate of suns energy striking in watt/m
    ^2
4 r=1.5*10^11 //radius of earths orbit in m
5 R=7*10^8 //radius of sun in m
6 sigma=5.7*10^-8 //Stefan-Boltzmann Constant in J/m^2
    sK^4
7
8 //calculation
9 T=((S*r^2)/(sigma*R^2))^(1/4)
10
11 mprintf("The surface temperature of the sun = %d K",
    T)
12 //The answer provided in the textbook is wrong.

```

Scilab code Exa 10.5 Cooling of the black body

```

1 clc;
2 clear;
3 T0=293 //temperature of the surrounding

```

```

4 T1=373 //temperature of the black body in case 1
5 T2=303 //temperature of the black body in case 2
6
7 //calculation
8
9 E1_by_E2=(T1^4-T0^4)/(T2^4-T0^4)
10 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

```

1 clc;
2 clear;
3 A=5*10^-4 //area in m^2
4 sigma=5.67*10^-8 //Stefan-Boltzmann Constant in J/m
    ^2sK^4
5 t=60 //time in s
6 T=727+273 //temperature in K
7 Q=300 //energy in J
8
9 //calculation
10
11 e=Q/(sigma*T^4*t*A)
12 mprintf("The emissivity of the surface area is = %1
    .2f",e)

```

Scilab code Exa 10.7 Cooling of a sphere

```

1  clc;
2  clear;
3  r=5*10^-2 //outer radius of copper sphere in m
4  T1=10^3//temperature in K
5  T2=300 //temperature in K
6  c=4*10^3 //specific heat in J/kg
7  rho=9*10^3 //density of copper in kg/m^3
8  sigma=5.67*10^-8 // Stefan-Boltzmann Constant in J/m
    ^2sK^4
9
10 //calculation
11 t=((rho*r*c)/(9*sigma))*((1/T2^3)-(1/T1^3))
12
13 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

```

1  clc;
2  clear;
3  rad=10^-3 //radius of wire in m
4  l=1 //length of the wire in m
5  T=900 //temperature of the body in K
6  T0=300 //temperature of the surrounding in K
7  sigma=5.68*10^-8 // Stefan-Boltzmann Constant in J/m
    ^2sK^4
8  alpha=7.8*10^-3 //temperature coefficient of
    resistance
9  delta_T=600 //difference in temperature of the body
    and surrounding in K
10 rho_300=%pi^2*10^-8 //resistivity in ohm-m
11
12 //calculation

```

```

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

```

Scilab code Exa 10.9 Energy density of a black body

```

1 clc;
2 clear;
3 h=6.63*10^-34 //Plancks constant in Joule-s
4 c=3*10^8 //velocity of light in m/s
5 lambda1=10^-3 //wavelength in m
6 lambda2=100*10^-9 //wavelength in m
7 T=1000 //temperature in K
8 k_B=1.38*10^-23 //Boltzmann constant in m^2 kg s^-2
    K^-1
9 d_lambda1=0.1*10^-3 //range of wavelength in m
10 d_lambda2=1*10^-9 //range of wavelength in m
11
12 //calculation
13 //case (a) when the range of wavelength is between
    1-1.1 mm
14 E=exp((h*c)/(lambda1*k_B*T)) //calculating the
    exponential term of the eqn
15 U_lambda1=((8*pi*h*c*d_lambda1)/(lambda1^5*(E-1)))
16 mprintf("The energy density for wavelength in range
    1-1.1 mm is = %1.2e J/m^3.\n",U_lambda1)
17
18 //case (b) when the range of wavelength is between
    100-101 nm
19 E1=exp((h*c)/(lambda2*k_B*T)) //calculating the
    exponential term of the eqn
20 U_lambda2=((8*pi*h*c*d_lambda2)/(lambda2^5*(E1-1)))

```

```

21 mprintf("The energy density for wavelength in range
    100–101 nm is = %1.2e J/m^3.",U_lambda2)
22 //The answer provided in the textbook is wrong.
23
24 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 densities predicted
    are same.")

```

Scilab code Exa 10.10 Photoelectric effect

```

1 clc;
2 clear;
3 W=2.3*1.6*10^-19 //Energy required to remove
    electron in eV
4 h=6.63*10^-34 //Plancks constant in J-s
5 c=3*10^8 //velocity of light in m/s
6
7 //calculation
8 lambda_0=(h*c)/W
9 printf("
\n The threshold wavelength is %1.3e.",
    lambda_0)
10 //The answer provided in the textbook is wrong.

```

Scilab code Exa 10.11 Retarding potential

```

1 clc;
2 clear;

```

```

3 W=1.2*1.6*10^-19 //work function in eV
4 h=6.6*10^-34 //Plancks constant in J-s
5 v=5.5*10^14 // frequency of light in Hz
6 e=1.6*10^-19 //charge in C
7
8 V_s=((h*v)-W)/e
9
10 mprintf("The stopping potential is = %1.2f volt",V_s
)
11 //Answer varies due to round off error.

```

Scilab code Exa 10.12 Photoelectric effect

```

1 clc;
2 clear;
3 h=6.63*10^-34 //Plancks constant in J-s
4 v0=6*10^14 // threshold frequency of light in Hz
5 e=1.6*10^-19 //charge in C
6 V_s=3 //stopping potential in V
7
8 //calculation
9 v=((e*V_s)/h)+v0
10 mprintf("The frequency of light which ejects
    electrons from the surface is %1.3e Hz",v)

```

Scilab code Exa 10.13 Photoelectric effect

```

1 clc;
2 clear;

```

```

3 h=6.63*10^-34 //Plancks constant in J-s
4 v=3*10^8 // frequency of light in Hz
5 e=1.6*10^-19 //charge in C
6 lambda=200*10^-9 //wavelength in m
7 W=4.2 //work function in Joule
8 c=3*10^8 //velocity of light in m/s
9
10 //calculation
11 E=(h*c)/(lambda)//energy in J
12 E_v=E/e //energy in eV
13
14 //case (1)
15 //(a)
16 E_k=E_v-W
17 mprintf("The kinetic energy of the fastest electrons
           is = %d eV\n",E_k)
18
19 //(b)
20 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)
21
22 //case(2)
23 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)
24
25 //case(3)
26 lambda_0=(h*c)/(W*e)
27 mprintf("The cut off wavelength for aluminium is %1
           .1e m",lambda_0)

```

Scilab code Exa 10.14 Work function for caesium

```
1  clc;
2  clear;
3  P=10^-3 //power in watt
4  h=6.62*10^-34 //Plancks constant in J-s
5  v=3*10^8 //frequency of light in Hz
6  lambda=4560*10^-10 //wavelength in m
7  eff=0.005 //quantum efficiency
8  e=1.6*10^-19 //charge in C
9
10 //calculation
11 E=(h*v)/lambda //energy of each photon in joules
12 N=P/E //no of photons incident on the metal per sec
13 N_e=N*eff //no of electrons released per sec
14 I=N_e*e
15
16 mprintf("The photoelectric current is = %1.3f micro-
    amp",I*10^6) //multiplying by 10^6 to convert
    from ampere to micro-ampere.
17 //The Answer provided in the textbook is wrong.
```

Scilab code Exa 10.15 Photoelectric effect

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

```

10 //calculation
11 h=(e*(V1-V2)*(lambda1)*(lambda2))/(c*(lambda2-
    lambda1))
12
13 mprintf("\nThe Plancks constant is = %1.3e J-s\n",h)
14 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

```

1  clc;
2  clear;
3  h=6.63*10^-34 //plancks constant in J-s
4  c=3*10^8 //velocity of light in m/s
5  lambda=180*10^-9 //wavelength in m
6  W=2*1.6*10^-19 //work function in Joule
7  m=9.1*10^-31 //mass in kg
8  e=1.6*10^-19 //charge in C
9  B=5*10^-5 //magnetic flux density in Tesla
10
11 //calculation
12 E=((h*c)/lambda)-W //kinetic energy in J
13 v=sqrt((2*E)/m) //velocity in m/s
14 r=(m*v)/(e*B)
15
16 mprintf("The radius of the circular path in magnetic
    field is = %1.3f m",r)

```

Scilab code Exa 10.17 Scattering angle

```
1  clc;
2  clear;
3  h=6.63*10^-34 //Plancks constant in J-s
4  c=3*10^8 //velocity of light in m/s
5  E0=6.20*10^3 //energy of photon in keV
6  freq_s=0.5/100 //frequency shift
7  m=9.1*10^-31 //mass in kg
8
9
10
11 //CALCULATION
12 lambda0=(h*c)/(E0*1.6*10^-19) //wavelength in m
13 delta_E=(freq_s*E0)/10^3 //Loss in energy of photon
    in keV
14 E=(E0/10^3)-delta_E //energy of scattered photon on
    keV
15 lambda=(h*c)/(E*10^3*1.6*10^-19) //wavelength of
    scattered photon in m
16 delta_lambda=lambda-lambda0 //compton shift
17 phi=acosd(1-(m*c*delta_lambda)/h)
18
19 mprintf("The angle through which Xray is scattered
    is = %2.1f degree",phi)
20 //The answer varies due to round off error.
```

Scilab code Exa 10.18 Compton shift

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

```

5 m=9.1*10^-31 //mass in kg
6 lambda_1=100*10^-12 //wavelength in m
7 e=1.6*10^-19 //charge in C
8
9
10 //calculation
11 delta_lambda=(h/(m*c)) //wavelength in m
12 mprintf("The compton shift is = %1.2e m\n",
    delta_lambda)
13
14 lambda_0=lambda_1-delta_lambda //wavelength of the
    scattered photon in m
15 delta_E=(h*c*delta_lambda)/(lambda_1*lambda_0)
16 mprintf("\nThe kinetic energy imparted to the
    electron is = %1.2e J or %1.2f eV",delta_E,
    delta_E/e)
17 //The answer provided in the textbook is wrong.

```

Scilab code Exa 10.20 Scattering angle

```

1 clc;
2 clear;
3 E0=100 //energy of the incident photon in keV
4 E=90 //energy of the scattered photon in keV
5 m=9.1*10^-31 //mass in kg
6 c=3*10^8 //velocity of light in m/s
7
8 //calculation
9 delta_E=E0-E //energy lost in keV
10 mc_square=(m*c^2)/(1.6*10^-19*10^3) //calculating
    one part of the formula
11 phi=acosd(1-(delta_E/E*mc_square/E0))
12

```

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

Scilab code Exa 10.21 DeBroglie wavelength

```
1 clc;
2 clear;
3 KE=10*1.6*10-19 //energy in J
4 m=9.1*10-31 //mass in kg
5 h=6.63*10-34 //Plancks constant in J-s
6 m_h=2*10-3 //molecular weight of hydrogen in kg
7 a=6.023*1023 //Avogadros constant in mol-1
8 v=2200 //velocity in m/s
9 m_g=45*10-3 //mass of golf ball in kg]
10 v_g=22 //velocity of golf ball in m/s
11
12 //calculation
13 //case (a)
14 lambda=((h/sqrt(2*m*KE))/10-9) //converting from m
    to nm by dividing by 10-9
15 mprintf("The de-Broglie wavelength is = %1.3f nm\n",
    lambda) //The answer varies due to round off
    error.
16
17 //case (b)
18 m=m_h/a //mass in kg
19 lambda=((h/(m*v))/10-9) //converting from m to nm
    by dividing by 10-9
20 mprintf("The de-Broglie wavelength is = %1.3f nm \n"
    ,lambda)
21
22 lambda1=h/(m_g*v_g) //Wavelength in m
23 mprintf("The de-Broglie wavelength of the golf ball
```

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

Scilab code Exa 10.22 DeBroglie wavelength

```
1 clc;
2 clear;
3 h=6.63*10^-34 //Plancks constant in J-s
4 K_b=1.38*10^-23 //Boltzmanns constant in m^2 kg s
    ^-2 K^-1
5 T=300 //Temperature in K
6 m=1.00878*1.66*10^-27 //mass of neutron in kg
7
8 //calculation
9 lambda=((h/sqrt(3*m*K_b*T))/10^-9) //converting from
    m to nm by dividing by 10^-9 ,wavelength in nm
10
11 mprintf("The de-Broglie wavelength is = %1.3f nm",
    lambda)
```

Scilab code Exa 10.23 DeBroglie wavelength

```
1 clc;
2 clear;
3 m=9.1*10^-31 //mass in kg
4 h=6.63*10^-34 //Plancks constant in J-s
5 e=1.6*10^-19 //charge in C
6 lambda=0.1 //wavelength in nm
7
8 //calculation
```

```

9 V=(((h/(sqrt(2*m*e)))*10^9)/(lambda))^2 //
    multiplying by 10^9 to convert from m to nm
    according to textbook convention , voltage in volts
10
11 mprintf("The voltage to which electron can be
    accelerated is = %3.2f volts",V)
12 //The answer varies due to round off error.

```

Scilab code Exa 10.24 DeBroglie wavelength

```

1 clc;
2 clear;
3 KE=0.04*1.6*10^-19 //energy in J
4 m=1.675*10^-27 //mass of neutron in kg
5 h=6.63*10^-34 //Plancks constant in J-s
6 c=3*10^8 //velocity of light in m/s
7
8 //calculation
9 lambda=(h/sqrt(2*m*KE))/10^-9 //Wavelength in nm
10 v_g=h/(lambda*10^-9*m) //Group Velocity in m/s
11 v_p=(c^2)/v_g //Phase Velocity in m/s
12 E=(h*c)/(lambda*10^-9) //Energy of neutron in J
13
14 mprintf("The de-Broglie wavelength is = %1.3f nm\n",
    lambda)
15 mprintf("The group velocity is = %1.2e m/s\n",v_g)
16 mprintf("The phase velocity is = %1.2e m/s\n",v_p)
17 mprintf("The energy of the neutron is = %1.2e J",E)

```

Scilab code Exa 10.25 Group velocity for wave packet

```
1 clc;
2 clear;
3 g=9.8 //acceleration due to gravity in m/s^2
4 lambda=10 //wavelength in m
5
6 //calculation
7
8 v_g=sqrt((lambda*g*pi)/2)
9 mprintf("The group velocity is = %2.2f m/s",v_g)
```

Scilab code Exa 10.26 Braggs reflection

```
1 clc;
2 clear;
3 m=9.1*10^-31 //mass in kg
4 h=6.63*10^-34 //Plancks constant in J-s
5 e=1.6*10^-19 //charge in C
6 n=1 //first reflection maximum
7 tetha=60 //glancing angle
8 V=344 //voltage in V
9
10 //calculation
11 d=((n*h)/(2*sind(60)*sqrt(2*m*e*V)))/10^-9
12 mprintf("The interplanar distance is = %1.3f nm",d)
```

Scilab code Exa 10.27 Braggs spectrum


```

1  clc;
2  clear;
3  m=1.675*10^-27 //mass of neutron in kg
4  h=6.63*10^-34 //Plancks constant in J-s
5  n=1 //first reflection maximum
6  KE=0.04*1.6*10^-19 //energy in J
7  d=0.314*10^-9 //interplanar distance in m
8
9  //calculation
10
11 phi=asind((n*h)/(2*d*sqrt(2*m*KE)))
12 mprintf("The glancing angle is = %2.1f degree",phi)
13 //The answer varies due to round off error.

```

Scilab code Exa 10.28 Davisson Germer experiment

```

1  clc;
2  clear;
3  tetha=55 //braggs angle in degree
4  KE=0.25*1.6*10^-19 //enrgy in J
5  m=1.675*10^-27 //mass of neutron in kg
6  h=6.63*10^-34 //Plancks constant in J-s
7  n=1 //first reflection maximum
8
9  //calculation
10 d=((n*h)/(2*sind(tetha)*sqrt(2*m*KE)))
11 mprintf("The interplanar distance is = %1.1e m",d)

```

Scilab code Exa 10.29 Accuracy in locating position of electron

```

1  clc;
2  clear;
3  m=9.1*10-31 //mass of electron in kg
4  v=4*105 //velocity in m/s
5  u=10-4 //uncertainty in momentum
6  h=6.63*10-34 //plancks constant in J-s
7
8
9  //calculation
10 delta_p=u*m*v //in kg-m/s
11 delta_x=h/(2*%pi*delta_p*10-9) //dividing by 10-9
    to convert into nm to calculate uncertainty
12
13 mprintf("The uncertainty 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 Uncertainty of veliocity

```

1  clc;
2  clear;
3
4  //calculation
5  delpap_by_p=((1/(4*%pi))*100) //multiplying by 100
    to calculate percentage
6
7  mprintf("The percent uncertainty in its velocity is
    less than equal to %1.2f",delpap_by_p)//The
    answer varies due to round off error.

```

Scilab code Exa 10.31 Uncertainty in momentum

```
1  clc;
2  clear;
3  delta_x=5*10^-14 //diameter of nucleus in m
4  h=6.63*10^-34 //plancks constant
5  m=1.675*10^-27 //mass in kg
6
7  //calculation
8  p_min=h/(4*%pi*delta_x) //minimum momentum in kg-m/s
9  E_min=((p_min)^2/(2*m))
10
11 mprintf("The minimum kinetic energy of the nucleon
    is = %0.2e J",E_min)
```

Scilab code Exa 10.32 Laser transition

```
1  clc;
2  clear;
3  h=6.63*10^-34 //Plancks constant in J-s
4  c=3*10^8 //velocity of light in m/s
5  lambda=694.5*10^-9 //wavelength in m
6  delta_t=10^-3
7
8  //calculation
9  delta_lambda=abs(-(lambda^2/(4*%pi*c*delta_t)))
10
```

```
11 mprintf("The natural line width of laser transition  
    is = %1.2e m",delta_lambda)  
12 //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

```
1 clc;
2 clear;
3 I=10*10^-3 //current in Ampere
4 e=1.6*10^-19 //charge in C
5 h=6.63*10^-34 //Plancks constant in J-s
6 c=3*10^8 //velocity of light in m/s
7 V=25*10^3 //voltage in V
8
9 n=(I/e)
10 mprintf("The no of electrons striking the target are
    = %1.2e\n",n)
11
12 lambda_min=(h*c)/(e*V)
13 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

```

1  clc;
2  clear;
3  e=1.6*10^-19 //charge in C
4  h=6.63*10^-34 //Plancks constant in J-s
5  c=3*10^8 //velocity of light in m/s
6  n1=1 //first order maxima
7  n2=2 //second order maxima
8  V=50*10^3 //voltage in V
9  tetha=26 //Braggs angle in degree
10
11 //calculation
12 lambda_min=(h*c)/(e*V) //wavelength in m
13 d=(n1*lambda_min)/(2*sind(tetha))
14 mprintf("The interplanar spacing is = %1.2e m\n",d)
15
16 tetha2=asind((n2*lambda_min)/(2*d))
17 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

```

1  clc;
2  clear;
3  d=275 //interplanar distance in pm
4  tetha=45 //glancing angle in degree
5
6  //calculation
7  //case(1) when intensity maxima is 3
8  n1=3
9  lambda=(2*d*sind(tetha))/n1
10 disp("case (1)")
11 mprintf("The wavelength for n = %d is = %d pm\n",n1,

```

```

        ceil(lambda))
12
13 //case(2) when intensity maxima is 4
14 n2=4
15 lambda=(2*d*sind(tetha))/n2
16 disp("case (2)")
17 mprintf("The wavelength for n = %d is = %1.1f pm\n",
        n2,lambda)
18 ////The answer varies due to round off error.
19
20
21 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

```

1  clc;
2  clear;
3  lambda=0.180*10^-9 //wavelength in m
4  R=1.097*10^7 // in m^-1
5
6  //calculation
7  Z_star=sqrt(4/(3*lambda*R))
8  mprintf("The Z_star is = %d",Z_star)
9  Z=(Z_star+1)
10 mprintf("The atomic number is = %d",Z)
11
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1539 +1)
1540 mprintf("Atomic no is = %d,hence the element is
      cobalt",Z)
```

Scilab code Exa 11.5 Identifying impurity element

```
1 clc;
2 clear;
3 h=6.63*10^-34 //Plancks constant in J-s
4 c=3*10^8 //velocity of light in m/s
5 lambda=0.194*10^-9 //wavelength in m
6 E_ca=3.69 //energy of calcium target in keV
7 Z_ca=20 //atomic no of calcium
8 //calculation
9
10 E_imp=((h*c)/(lambda*1.6*10^-19))/10^3
11 Z_imp=(sqrt(E_imp/E_ca)*(Z_ca-1)+1)
12
13 mprintf("The atomic no is = %d,hence impurity is
      iron",Z_imp)
```

Scilab code Exa 11.6 Miller Indices


```

1  clc;
2  clear;
3  unit_cell_edge_x=(2) //intercept of x
4  unit_cell_edge_y=(-3) //intercept of y
5  unit_cell_edge_z=(6) //intercept of z
6
7  //calculations
8  Reciprocal_x=1/unit_cell_edge_x //reciprocal value
   of miller index x
9  Reciprocal_y=1/unit_cell_edge_y //reciprocal value
   of miller index y
10 Reciprocal_z=1/unit_cell_edge_z //reciprocal value
   of miller index z
11 Reciprocal_xyz=int32([unit_cell_edge_x,
   unit_cell_edge_y,unit_cell_edge_z]) //creating
   integer vector for LCM calculation
12 LCM=double(lcm(Reciprocal_xyz)) //LCM of unit cell
   edges
13 coordinate_A=(Reciprocal_x)*LCM
14 coordinate_B=Reciprocal_y*LCM
15 coordinate_C=Reciprocal_z*LCM
16
17 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

```

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

```

```

6
7 //calculations
8 Reciprocal_x=1/unit_cell_edge_x //reciprocal value
   of miller index x
9 Reciprocal_y=1/unit_cell_edge_y //reciprocal value
   of miller index y
10 Reciprocal_z=1/unit_cell_edge_z //reciprocal value
   of miller index z
11 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
12 LCM=double((lcm(Reciprocal_xyz))) //LCM of unit cell
   edges
13 coordinate_A=(Reciprocal_x)*LCM
14 coordinate_B=Reciprocal_y*LCM
15 coordinate_C=(Reciprocal_z)*LCM
16
17 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

```

1 clc;
2 clear;
3 OA=0.121 //cell parameter in nm
4 OB=0.184 //cell parameter in nm
5 OC=0.197 //cell parameter in nm
6 OA_by_OB=3/2 //ratio of fractional intercepts
7 OA_by_OC=1/2 //ratio of fractional intercepts
8
9 //calculation

```

```

10 OB=((2/3)*OB)
11 OC=(2)*OC
12 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

```

1  clc;
2  clear;
3  a=0.82 //cell parameter in nm
4  b=0.94 //cell parameter in nm
5  c=0.75 //cell parameter in nm
6  h=1 //x intercept of parallel plane
7  k=2 // intercept of parallel plane
8  l=3 //z intercept of parallel plane
9
10 //calculation
11 d_123=((h/a)^2+(k/b)^2+(l/c)^2)^(-1/2)
12 d_246=d_123/2
13 mprintf("The interplanar distance between 123 planes
    is = %1.2f and 246 planes is = %1.3f",d_123,
    d_246)
14 //The answer provided in the textbook is wrong.

```

Scilab code Exa 11.10 Interplanar spacing in the reflecting planes

```

1  clc;
2  clear;
3  lambda=0.12 //wavelength in nm

```

```

4 tetha=28 //Braggs angle in degree
5 n=2 //second order reflection
6
7 //calculation
8 d=(n*lambda)/(2*sind(28))
9
10 mprintf("The interplanar spacing of the reflecting
    planes of the crystal is = %1.2f nm",d)

```

Scilab code Exa 11.11 Braggs reflection

```

1 clc;
2 clear;
3 n=3 //third order reflection
4 lambda=97 //wavelength in pm (third order)
5 tetha1=23 //Braggs angle for first order in degree
6 tetha2=60 //Braggs angle for third order in degree
7
8 //calculation
9 lambda_1=(n*lambda*sind(tetha1))/sind(tetha2)
10 d=(n*lambda)/(2*sind(tetha2))
11
12 mprintf("\n\nThe wavelength that undergoes first order
    reflection is = %d pm\n",lambda_1)
13 mprintf("The interplanar spacing is = %d pm",d)

```

Scilab code Exa 11.12 Braggs reflection

```

1 clc;

```

```

2 clear;
3 a=0.2 //lattice parameter in nm
4 h=1 //x intercept of parallel plane
5 k=1 //y intercept of parallel plane
6 l=1 //z intercept of parallel plane
7 phi=87 //incident angle in degree
8
9 //calculation
10 tetha=phi/2
11 d=(a/sqrt(h^2+k^2+l^2))
12 lambda=(2*d*sind(tetha))
13
14 mprintf("The wavelength is = %1.3f nm\n",lambda)
15 mprintf("The Braggs angle is = %2.1f degree",tetha)

```

Scilab code Exa 11.13 Interplanar spacing in Braggs reflection

```

1 clc;
2 clear;
3 h=6.63*10^-34 //Plancks constant in J-s
4 m=9.1*10^-31 //mass in kg
5 e=1.6*10^-19 //charge in C
6 V_0=844 //voltage in V
7 n=1 //first order reflection
8 tetha=58 //Braggs angle in degree
9
10 //calculation
11 lambda=(h/sqrt(2*m*e*V_0)) //wavelength in m
12 d=((n*lambda)/(2*sind(tetha)))
13 mprintf("The interplanar spacing is = %1.2e m",d)
14 //The answer varies due to round off error.

```

Scilab code Exa 11.14 Lattice constant

```
1  clc;
2  clear;
3  h=6.63*10^-34 //Plancks constant in J-s
4  m=1.804*10^-27 //mass of neutron in kg
5  K_b=1.38*10^-23 //Boltzmann constant in J/K
6  tetha=30 //Braggs angle in degree
7  n=2 //second order reflection
8  T=300 //temperature in K
9
10 //calculation
11 lambda=h/sqrt(3*m*K_b*T)
12 a=sqrt((3*lambda))/2
13
14 mprintf("The lattice constant is = %1.2e m.",a)
15 //The answer provided in the textbook is wrong.
```

Scilab code Exa 11.15 Unit cell dimensions

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

```

7 k=0 //lattice parameter for y axis
8 l=0 //lattice parameter for z axis
9
10 //calculations
11 sin_square_theta=sind(theta)^2 //angle in degrees
12 alpha=(lambda/2)*((h^2+k^2+l^2)/sqrt(
    sin_square_theta))
13
14 mprintf("The lattice constant is alpha = %d pm",ceil
    (alpha))

```

Scilab code Exa 11.16 Lattice constant and cubic structure

```

1 clc;
2 clear;
3 lambda=0.154 //wavelength in nm
4 theta1=20 //angle in degree
5 theta2=29 //angle in degree
6 h=1 //x intercept of parallel plane
7 k=1 //y intercept of parallel plane
8 l=0 //z intercept of parallel plane
9 //calculation
10 ratio=sind(theta1)^2/sind(theta2)^2 //ratio of sin^2
    theta values of first and second angles
11 alpha=(lambda/2)*sqrt((sqrt(h^2+k^2+l^2))/sind(
    theta1)^2)
12
13 mprintf("The crystal structure is bcc since the
    ratio is %1.1f\n",ratio)
14 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

```
1  clc;
2  clear;
3  //Consider the peak value 8 of observation for
   calculation in the sum
4  lambda=0.07107 //wavelength in nm
5  theta=29.71 //angle in degree
6  h=4 //x intercept of parallel plane
7  k=0 //y intercept of parallel plane
8  l=0 //z intercept of parallel plane
9
10 //calculation
11 d_400=(lambda/(2*sind(theta))) //interplanar
   distance in nm
12 alpha=d_400*(sqrt(h^2+k^2+l^2))
13
14 mprintf("lattice constant of peak no.1 is (110)\n")
```

Scilab code Exa 11.18 Effective temperature of neutron

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



```

8 K_b=1.38*10^-23 //Boltzmann constant in J/K
9 H=6.63*10^-34 //Plancks constant in J-s
10 m=1.67*10^-27 //mass of nuetron in kg
11
12 //calculation
13
14 d=(a/sqrt(h^2+k^2+l^2)) //interplanar distance in nm
15 lambda=2*d*sind(28.5) //wavelength in nm
16 T=(H^2)/(3*m*K_b*((lambda*10^-9)^2))
17
18 mprintf("The effective temperature of neutrons is =
    %d K",T)

```

Scilab code Exa 11.19 Braggs angle

```

1 clc;
2 clear;
3 H=6.626*10^-34 //Plancks constant in J-s
4 m=9.1*10^-31 //mass in kg
5 e=1.6*10^-19 //charge in C
6 V_0=80 //Potential difference in V
7 a=0.35 //lattice parameter in nm
8 h=1 //x intercept of parallel plane
9 k=1 //y intercept of parallel plane
10 l=1 //z intercept of parallel plane
11
12 //calculation
13 lambda=H/sqrt(2*m*e*V_0) //wavelength in m
14 d_111=(a/sqrt(h^2+k^2+l^2))*10^-9 //interplanar
    distance in m
15 theta1_degrees= floor(asin((lambda)/(2*d_111)))*(180/

```

```

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

```

Scilab code Exa 11.20 Braggs reflection

```

1  clc;
2  clear;
3  tetha_A=21 //Braggs angle in degree
4  tetha_B_degree=21 // part of Braggs angle in degree
5  tetha_B_minute=23 //part of Braggs angle in minute
6  h=1 //x intercept of parallel plane
7  k=1 //y intercept of parallel plane
8  l=1 //z intercept of parallel plane
9  lambda=0.152 //wavelength of xray in nm
10
11 //calculation
12 //case(1) for sample A
13 d_111=lambda/(2*sind(tetha_A))
14 a=d_111*sqrt(h^2+k^2+l^2)
15 mprintf("\nThe lattice parameter of sample A is= %1
    .3f nm\n",a)
16
17 //case(2) for sample B
18 tetha_B_decdeg=tetha_B_degree+(tetha_B_minute/60)
19 d_111=lambda/(2*sind(tetha_B_decdeg))
20 a=d_111*sqrt(h^2+k^2+l^2)
21 mprintf("The lattice parameter of sample B is = %1.3
    f mm\n",a)

```

Scilab code Exa 11.21 Braggs reflection

```
1  clc;
2  clear;
3  lambda=0.171 //wavelength of X-ray in nm
4  tetha_1=30 //Braggs angle in degree
5  tetha_2_degrees=35 //part of Braggs angle in degrees
6  tetha_2_minutes=17 //part of Braggs angle in minutes
7  h=1 //x intercept of the parallel plane
8  k=1 //y intercept of the parallel plane
9  l=0 //z intercept of the parallel plane
10
11 // calculation
12 // case (A)
13 d_110=lambda/(2*sind(tetha_1))
14 a=d_110*sqrt(h^2+k^2+l^2)
15 mprintf("(i)The lattice parameter is = %1.3f nm\n",a
    )
16
17 // case (B)
18 h=2 //x intercept of the parallel plane
19 k=0 //y intercept of the parallel plane
20 l=0 //z intercept of the parallel plane
21 tetha_2_decdeg=tetha_2_degrees+(tetha_2_minutes/60)
22 d_110=lambda/(2*sind(tetha_2_decdeg))
23 a=d_110*sqrt(h^2+k^2+l^2)
24 mprintf("(ii)The lattice parameter is = %1.4f nm\n",
    a)
25 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)
26
```

```

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

```

Scilab code Exa 11.22 Braggs reflection

```

1  clc;
2  clear;
3  lambda=0.154 //wavelength in nm
4  D=0.2494 //diameter in D
5
6  //calculation
7  d=lambda/2 //interplanar distance in nm
8  hkl_parameters=((2*D)/(d*sqrt(3)))^2
9
10
11
12 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
13 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

```
1  clc ;
2  clear ;
3  m=1.67*10^-27 //mass of particle in kPP
4  L=0.1*10^-9 //width in nm
5  n=3 //quantum number
6  h=6.63*10^-34 //Plancks constant in J-s
7
8  //calculation
9  //(1)
10 E=(n^2*h^2)/(8*m*L^2)
11 mprintf("The energy of the particle is = %2.2e
    Joules\n",E)
12 //The answer provided in the textbook is wrong.
13
14 //(2)
15 lambda=(2*L)/n
16 p=h/lambda
17 mprintf("The momentum of the particle is = %1.2e kg-
    ms^-1\n",p)
```

```

18
19 // (3)
20 P=((1/L)*(L/3)) //after integration
21 mprintf("The probability of finding particle between
           x=0 and x=L/3 is = %f",P)

```

Scilab code Exa 12.2 Wavelength of radiation

```

1 clc;
2 clear;
3 h=6.63*10^-34 //Plancks constant in J-s
4 m=9.1*10^-31 //mass in kg
5 L=10^-9 //potential width in m
6 c=3*10^8 //velocity of light in m/s
7
8 //calculation
9 lambda=(8*m*c*L^2)/(27*h)
10 mprintf("The wavelength of radiation emitted is %1.2
           e m or 122 nm",lambda)
11 //The answer varies due to round off error.

```

Scilab code Exa 12.3 Uncertainty in momentum

```

1 clc;
2 clear;
3 delta_x=10^-9 //uncertainty in the position of
                electron in m
4 h=6.63*10^-34 //Plancks constant in J-s
5

```

```

6 // calculation
7 delta_p=h/(4*%pi*delta_x)
8
9 mprintf("The uncertainty in momentum of the
          electron is greater than or equal to %1.1e kgms
          ^-1",delta_p)
10 //The answer provided in the textbook is wrong.

```

Scilab code Exa 12.4 Potential Well

```

1 clc;
2 clear;
3 L=0.5*10^-9 //width in m
4 m=9.1*10^-31 //mass in kg
5 V_0=15*1.6*10^-19 //height of the potential well in
   J
6 h=6.63*10^-34 //Plancks constant in J-s
7
8 // calculation
9 n_max=(4*L*sqrt(m*V_0))/h
10
11 mprintf("The maximum quantum number possible is %d",
          n_max)

```

Scilab code Exa 12.5 Penetration distance of electron

```

1 clc;
2 clear;
3 m=9.1*10^-31 //mass in kg

```

```

4 h=6.63*10^-34 //Plancks constant in J-s
5 v=10^5 //velocity in m/s
6
7 //calculation
8 E=(m*v^2)/2 //in J
9 gam=(2*pi*sqrt(2*m*E))/h //in m^-1
10 d=1/(gam*10^-9) //dividing by 10^-9 to convert from
    m to nm
11
12 mprintf("The penetration distance of the electron is
    = %1.2 f nm",d)

```

Scilab code Exa 12.6 Tunneling probability

```

1 clc;
2 clear;
3 h=6.63*10^-34 //Plancks constant in J-s
4 m=9.1*10^-31 //mass in kg
5 E=2 //energy in eV
6 V_0=20 //height of potential barrier in eV
7 alpha=0.3*10^-9 //width of potential barrier in m
8 e=1.6*10^-19 //charge in C
9
10 //calculation
11 Gamma=(2*pi*(sqrt(2*m*(V_0-E)))*e)/h //in m^-1
12 T=((16*E*(V_0-E)/V_0^2)*exp(-2*(Gamma)*alpha))
13 mprintf("The tunneling probability is = %1.2e",T)
14 //The answer provided in the textbook is wrong.

```
