Scilab Textbook Companion for Applied Physics for Engineers by V. Rajendran and A. Marikani[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

Gravity

Scilab code Exa 1.1 Time Period

```

clc
clear

//INPUT DATA
L=1;//Length of the bar in m
l=0.25;//Length of the pemdulum in m

//CALCULATIONS
k=sqrt((L^2)/12);//Radius of gyration m
T=sqrt(((k^2/l)+l)/9.8)*2*3.14;//Time period of pendulum in s

//OUTPUT
mprintf('Time period of the pendulum is %3.3f sec',T)
```

Scilab code Exa 1.2 Acceleration due to gravity

```

clc
clear

//INPUT DATA
T=2.223;//Time taken for 1 oscillation in sec
L=1.228;//Length of the pendulum in m

//CALCULATIONS
g=((4*3.14^2*L)/(T^2));//Acceleration due to gravity in m.s^-2

//OUTPUT
mprintf('The acceleration due to gravity is %3.2f m s^-2',g)
```

Scilab code Exa 1.3 Time Period and distance

```

clc
clear

//INPUT DATA
l=1.2;//Length of of bar in m

//CALCULATIONS
k=sqrt(l^2/12);//Radius of gyration in m
T=sqrt(((k^2/(l/2))+(l/2))/9.8)*2*3.14;//Time period of the pendulum in s
L=((9.8*T^2)/(4*3.14^2));//Length in m
D=L-(l/2);//Another point where pendulum has same timeperiod in m

//OUTPUT
mprintf('The time period of pendulum is %3.3f s\
```

```
nDistance of another point from centre of gravity on bar with same time period is %3.1f m',T,D)
```

Scilab code Exa 1.4 Time Period

```

clc
clear

//INPUT DATA
L=1;//Length of pendulum in m
B=0.05;//Width of pendulum in m

//CALCULATIONS
k=sqrt((L^2+B^2)/12);//Radius of gyration in m
D=((L/2)-k)*100;//distance of point of minimum time period from one end in cm

//OUTPUT
mprintf('The minimum time period is obtained at %3.2f cm',D)
```

Chapter 2

Elasticity

Scilab code Exa 2.1 Youngs Modulus

```
clc
clear
//Input data
l=3//Length of the wire in m
A=(6.25*10^-5)//Area in m^2
dl=(3*10^-3)//Increase in length in m
F=(1.2*10^3)//Tension in N

//Calculations
Y=((F*l)/(A*dl))/10^10//Young's modulus in N/m^2 *10^10

//Output
printf('Youngs modulus of the wire is %3.2f *10^10 N/m^2',Y)
```

Scilab code Exa 2.2 Increase in length

```
clc
clear
//Input data
l=2.75//Length of steel wire in m
d=(1*10^-3)//Diameter of the wire in m
M=1//Applied load in kg
Y=(2*10^11)//Youngs modulus in N/m^2

//Calculations
T=(M*9.8)//Tension in N
dl=((T*l)/(3.14*(d/2)^2*Y))/10^-4//Increase in
    length in m *10^-4

//Output
printf('The increase in length of wire is %3.5f
    *10^-4 m',dl)
```

Scilab code Exa 2.3 Shearing Stress

```
clc
clear
//Input data
d=[6,6,2]//Dimensions of the rectangular solid in cm
F=0.3//Force applied in N
d1=5//Displacement relative to the lower surface in
    mm

//Calculations
s=(F/(d(1)*d(2)*10^-4))//Shear stress in N/m^2
q=(d1*10^-3)/(d(3)*10^-2)//Shear strain
rm=(s/q)//Rigidity modulus in N/m^2

//Output
printf('Shearing stress is %3.2f N/m^2 \n Shear
    strain is %3.2f \n Rigidity modulus is %3.2f N/m
```

```
^2',s,q,rm)
```

Scilab code Exa 2.4 Shearing Force

```
clc
clear
//Input data
d=1.5//Distortion in the block in cm
t=30//Thickness of the block in cm
A=12//Surface area of the block in m^2
s=(2.5*10^10)//Shear modulus of aluminium in N/m^2

//Calculations
F=((s*A*10^-4*d*10^-2)/(t*10^-2))/10^6//Shearing
    force in N

//Output
printf('Shearing force is %3.1f *10^6 N',F)
```

Scilab code Exa 2.6 Poissions ratio

```
clc
clear
//Input data
Y=(7.25*10^10)//Youngs modulus of silver in N/m^2
K=(11*10^10)//Bulk modulus of silver in N/m^2

//Calculations
s=(3*K-Y)/(6*K)//Poissons ratio

//Output
printf('Poissons ratio for silver is %3.2f',s)
```

Scilab code Exa 2.7 Lateral Compression

```
clc
clear
//Input data
l=3//Length of the wire in m
Y=(12.5*10^10)//Youngs modulus in N/m^2
d=1//diameter of the wire in mm
M=10//load applied in kg
p=0.26//Poissons ratio

//Calculations
dl=(M*9.8*l)/(3.14*(d/2)^2*10^-6*Y)//Increase in length in m
sl=(p*dl)/l//Lateral strain
dd=(sl*d*10^-3)//Decrease in diameter in m
E=dl/10^-3//Extensio produced in m*10^-3
lc=dd/10^-7//Lateral compression in m*10^-7

//Output
printf('Extension produced is %3.2f *10^-3 m \n Lateral compression produced is %3.3f *10^-7 m',E,lc)
```

Scilab code Exa 2.8 Couple to be applied

```
clc
clear
//Input data
l=1//Length of wire in m
d=0.001//diameter of the wire in m
q=(90*3.14)/180//Twist angle in radians
```

```
r=(2.8*10^10)//Rigidity modulus in N/m^2

//Calculations
C=((3.14^2*r*(d/2)^4)/(4*l))/10^-3//Couple to be applied in N.m

//Output
printf('The couple to be applied is %3.4f *10^-3 N.m',C)
```

Scilab code Exa 2.9 Poissions ratio

```
clc
clear
d=(0.82*10^-3)//Diameter of the wire in m
dl=(1*10^-3)//Length of elongation produced in m
F=(0.33*9.8)//Force in N
q=1//Angular twist in radians
T=(10*10^-5)//Torque in N
n=(2.2529*10^9)//Rigidity modulus in N/m^2

//Calculations
Y=(F/(3.14*(d/2)^2*dl))//youngs modulus *L in N/m^2
s=(Y/(2*n))-1//Poissons ratio

//Output
printf('Poissons ratio is %3.4f',s)
```

Scilab code Exa 2.10 Change in Volume

```
clc
clear
//Input data
```

```
p=(1.01*10^5)//Standard atmospheric pressure in N/m
   ^2
K=(16*10^10)//Bulk modulus in N/m^2
dp=(p-10^2)//Change in pressure in N/m^2

//Calculations
dvv=(dp/K)//Change in volume to initial volume
fv=(dvv/10^-7)//Fractional change in the volume
   *10^-7

//Output
printf('The change in volume of steel bar is %3.1f
   *10^-7 *V m^3',fv)
```

Chapter 3

Special Theory of Relativity

Scilab code Exa 3.1 Relative Speed

```

clc
clear

//INPUT DATA
u=3.5*10^2;//Speed of the cyclist in m/s
v=2*10^3;//Speed of the train in m/s
c=3*10^8;//Speed of light in m/s

//CALCULATIONS
U=((u+v)/(1+((u*v)/c^2)))/1000//Relative speed in km
   /s

//OUTPUT
mprintf('The relative speed is %3.2f*10^3 m/s',U)
```

Scilab code Exa 3.2 Mass of Object

```

clc
clear

//INPUT DATA
c=3*10^8;//Speed of light in m/s

//CALCULATIONS
v=((sqrt(3)*c)/2)/10^8//Speed in m/s

//OUTPUT
mprintf('The mass of the object is double its mass at rest , when its speed is %3.3f*10^8 m/s',v)
```

Scilab code Exa 3.3 Mass of electron

```

clc
clear

//INPUT
E=1*1.6*10^-16;//Kinetic energy of electron in J
m=9.1*10^-31;//Mass of electron in Kg
c=3*10^8;//Speed of light in m/s

//CALCULATIONS
v=sqrt((2*E)/m)//Velocity of the electron in m/s
M=(m/sqrt(1-(v^2/c^2)))/10^-31//Mass of the electron in kg

//OUTPUT
mprintf('Mass of electron having energy 1 keV is %5.4f*10^-31 kg',M)
```

Scilab code Exa 3.4 Time Interval

```
clc
clear

//INPUT
v=3*10^7;//Speed of the spaceship in m/s
t=1;//Time interval between the signals in s
c=3*10^8;//Speed of light in m/s

//CALCULATIONS
T=t/sqrt(1-(v^2/c^2))//Time interval between
    sucessive signals in s

//OUTPUT
mprintf('The time interval between sucessive signals
     as seen from the control room is %3.3f s',T)
```

Scilab code Exa 3.5 Speed of rocket

```
clc
clear

//INPUT
T=2;//Time on earth in years
t=1;//Time on satilite in years
c=3*10^8;//Speed of light in  m/s

//CALCULATIONS
v=c*sqrt(1-(t^2/T^2))/10^8//Velocity in m/s
```

```
//OUTPUT
mprintf('The speed of the rocket is %5.3f*10^8 m/s',
   v )
```

Scilab code Exa 3.6 Properties

```

clc
clear

//INPUT
t=2*10^-6;//The life time of micro mesons in s
v=2.994*10^8;//Speed of micro mesons in m s^-1
c=3*10^8;//Speed of light in m s^-1

//CALCULATIONS
T=(t/sqrt(1-(v^2/c^2)))/10^-5//Life time of micro
   mesons in s
D=v*T*10^-5//Distance travelled by micro mesons in
   one life time in m
d=v*t//Distance travelled by the micro mesons if
   there is no relativistic effect in m

//OUTPUT
mprintf('The mean life time of micro mesons  is %f
   *10^-5 s \n',T)
mprintf('The distance traveled by micro mesons is %3
   .1f m \n',D)
mprintf('The distance traveled if there is no
   relativistic effect is %3.1f m \n',d)
```

Scilab code Exa 3.8 Contracted length

```
clc
clear

//INPUT
L=1.2;//Length of the satillite in m
v=0.98*3*10^8;//Speed of the satillite in m/s
c=3*10^8;//Speed of light in m s^-1

//CALCULATIONS
l=L*sqrt(1-(v^2/c^2))//The contracted length in m

//OUTPUT
mprintf('The contracted length is %3.4f m',l)
```

Scilab code Exa 3.9 Relativistic mass

```
clc
clear
//Input data
v=0.9//Velocity of the particle is 0.9c

//Calculations
x=1/sqrt(1-v^2)//x value for obtaining mass
E=(x-1)//E value for obtaining energy

//Output
printf('The relativistic mass of the particle is %3
   .3f mo \n The kinetic energy of the particle is
   %3.3f mo.c^2',x,E)
```

Scilab code Exa 3.10 Speed of electron

```
clc
clear
//Input data
E=2*10^6*1.6*10^-19//Energy of the electron in J
c=3*10^8//Velocity of light in m/s
mo=9.1*10^-31//Mass of the electron in kg

//Calculations
m=(E/c^2)+mo//Mass in kg. In textbook, the answer is
    wrong. The correct answer is 44.65*10^-31 kg
v=(c*sqrt(1-(mo/m)^2))/10^8//Velocity of the
    particle in m/s

//Output
printf('Velocity of the particle is %3.3f*10^8 m/s',
    v)
```

Chapter 4

Diffraction

Scilab code Exa 4.1 Angular Seperation

```
clc
clear
n=15000//Number of lines per inch
w=[5890,5896]//Wavelengths of the two sodium lines
   in Amgstrongs
n1=1//Order of diffraction

//Calculations
N=(n/2.54)*100//Number of lines present per meter
q1=asind(N*n1*w(1)*10^-10)//Angle of diffraction for
    D1 line in degrees
q2=asind(N*n1*w(2)*10^-10)//Angle of diffraction for
    D2 line in degrees
q=q2-q1//The angular seperation in degrees
x=(q*60)//The angular seperation in minutes
y=(x-int(x))*60//For output

//Output
printf('The angular seperation is %i minute %3.2f
   seconds',x,y)
```

Scilab code Exa 4.2 Minimum number of lines

```
clc
clear
//Input data
n=1//Order of diffraction
w=[5890,5896]//Wavelengths of the two sodium lines
   in angstroms

//Calculations
N=(w(1)*10^-10)/((w(2)-w(1))*10^-10*n)//Minimum
   number of lines in a grating which will just
   resolve in the first order

//Output
printf('Minimum number of lines in a grating which
   will just resolve in the first order is %3.0f',N)
```

Scilab code Exa 4.3 Third order

```
clc
clear
//Input data
ab=(15*10^-6)//Grating constant in m
w=(2.4*10^-6)//Wavelength in m
n=3//Order of diffraction

//Calculations
q=asind((n*w)/ab)//Angle at which third order is
   obtained
qx=(q-int(q))*60//For output
qy=(qx-int(qx))*60//For output
```

```
//Output
printf('Third order is obtained at %i degrees %3.0f minutes %3.2f seconds',q,qx,qy)
```

Scilab code Exa 4.4 Seperation of two lines

```
clc
clear
//Input data
w=[5000,5100]//Wavelengths of light in Armstrongs
N=6000//Number of lines drawn on the grating per cm
n=1//Order of diffraction
F=1//Focal length of the lens in m

//Calculations
q1=asind(N*100*n*w(1)*10^-10)//Angle of diffraction for D1 line in degrees
q2=asind(N*100*n*w(2)*10^-10)//Angle of diffraction for D1 line in degrees
x=F*(tand(q2)-tand(q1))*1000//Seperation of the two lines in mm

//Output
printf('Seperation of two lines in the first order spectrum is %3.1f mm',x)
```

Scilab code Exa 4.5 Dispersive power

```
clc
clear
//Input data
```

```
N=(5.9*10^5)//Number of lines drawn on the grating in lines/m
n=2//Order of diffraction
l=(6000*10^-10)//Wavelength of light used in m

//Calculations
q=asind(N*n*l)//Angle of diffraction in degrees
cosq=cosd(q)//Cosine of angle of diffraction
P=((n*N)/cosq)/10^6//Dispersive power* 10^6

//Output
printf('The dispersive power of the grating in the second order is %3.2f *10^6',P )
```

Scilab code Exa 4.6 Angular Seperation

```
clc
clear
//Input data
N=14438//Number of lines per inch
n=3//Order of diffraction
w=(4200*10^-10)//Wavelength of light used in m

//Calculations
x=(N/2.54)*100//Number of lines per m
dq=((n*x*10^-10)/sqrt(1-(x^2*n^2*w^2)))*(180/3.14)//Angular seperation in degrees. In textbook, it is given wrong as 0.14 degrees

//Output
printf('The angular seperation is %3.3f degrees',dq)
```

Scilab code Exa 4.7 Diffraction

```
clc
clear
//Input data
N=5000//Number of lines drawn on the grating per m
w=(5890*10^-10)//Wavelength of the light used in m

//Calculations
n=(1/(w*N*100))//Order of spectrum
x=ceil(n)//Rounding off to next integer

//Output
printf('Since n < %i, it is not possible to observe
    the fourth or higher order of diffraction',x)
```

Chapter 5

Laser and Fibre Optics

Scilab code Exa 5.1 Energy

```
clc
clear
//Input data
l=(5900*10^-10)//Wavelength of sodium D line in m
h=6.625*10^-34//Plancks constant in J.s
e=(1.602*10^-19)//Charge of electrons in Columbs
c=(3*10^8)//Velocity of light in m/s

//Calculations
E=((h*c)/l)/e//Energy emitted in eV

//Output
printf('The energy of the first excited state is %3
    .1f eV',E)
```

Scilab code Exa 5.2 Ratio of atoms

```
clc
```

```
clear
//Input data
T=250+273//Temperature in K
l=(5900*10^-10)//Wavelength of sodium D line in m
h=6.625*10^-34//Plancks constant in J.s
e=(1.602*10^-19)//Charge of electrons in Columbs
c=(3*10^8)//Velocity of light in m/s
k=(1.38*10^-23)//Boltzmann constant in J/K

//Calculations
N=exp((-h*c)/(k*T*l))/10^-21//The ratio between the atoms in the first excited state and the ground state *10^-21

//Output
printf('The ratio between the atoms in the first excited state and the ground state is %3.3f *10^-21',N)
```

Scilab code Exa 5.3 Ratio of emission

```
clc
clear
//Input data
T=250+273//Temperature in K
l=(5900*10^-10)//Wavelength of sodium D line in m
h=6.625*10^-34//Plancks constant in J.s
e=(1.602*10^-19)//Charge of electrons in Columbs
c=(3*10^8)//Velocity of light in m/s
k=(1.38*10^-23)//Boltzmann constant in J/K

//Calculations
N=(1/(exp((h*c)/(k*T*l))-1))/10^-21//The ratio between the stimulated emission and the spontaneous emission *10^-21
```

```

//Output
printf('The ratio between the stimulated emission
   and the spontaneous emission is %3.5f*10^-21',N)
```

Scilab code Exa 5.4 Difference in states

```
clc
clear
//Input data
no=1.76//Refractive index of the ruby rod
vo=4.3*10^14//Frequency in Hz
dvo=1.5*10^11//The doppler broadening in Hz
t21=4.3*10^-3//Lifetime of spontantaneous emission
   in s
tp=6*10^-9//Lifetime of photon in s
c=(3*10^8)//Velocity of light in m/s

//Calculations
dN=((4*3.14^2*vo^2*no^3*t21*dvo)/(c^3*tp))/10^23//
   The difference between the population of the
   excited state and the ground state in m^-3

//Output
printf('The difference between the population of the
    excited state and the ground state is %3.3f
   *10^23 m^-3',dN)
```

Scilab code Exa 5.5 Ratio of emission

```
clc
clear
//Input data
```

```
l=5000*10^-10//Wavelength of the incident light in m
T=300//Temperature in K
h=6.625*10^-34//Plancks constant in J.s
e=(1.602*10^-19)//Charge of electrons in Columbs
c=(3*10^8)//Velocity of light in m/s
k=(1.38*10^-23)//Boltzmann constant in J/K

//Calculations
v=(c/l)//Frequency of the incident light in Hz
N=(1/(exp((h*c)/(k*T*l))-1))/10^-42//The ratio
    between the stimulated emission and the
    spontaneous emission*10^-42

//Output
printf('The ratio of stimulated emission to the
    spontaneous emission is %3.4f*10^-42 \n This
    shows that the spontantaneous emission is more
    predominant than that of the stimulated emission.
     For stimulating emission, N2>>N1 should exist.\n
      Therefore, there is no amplification
    possibility. \n But, subsequent development in
    maintaining population inversion by pumping the
    atoms from lower level to higher level optically
    or electronically led to the discovery of lasers.
    ',N)
```

Scilab code Exa 5.6 Number of photons

```
clc
clear
//Input data
l=632.8*10^-9//Wavelength of the laser beam in m
P=2.3*10^-3//Power output in W
c=(3*10^8)//Velocity of light in m/s
h=6.625*10^-34//Plancks constant in J.s
```

```

//Calculations
f=(c/l)//Frequency of the photon emitted by the laser beam in Hz
E=h*f//Energy of a photon in J
n=((P*60)/E)/10^17//The number of photons emitted *10^17

//Output
printf('The number of photons emitted is %3.4f*10^17 photons/minute',n)
```

Scilab code Exa 5.7 Properties

```
clc
clear
//Input data
NA=0.16//Numerical aperture of the fibre
n1=1.45//Refractive index of the core
d=(90*10^-6)//Diameter of the core in m
l=0.9*10^-6//Wavelength in m

//Calculations
n2=sqrt(n1^2-NA^2)//Refractive index of the cladding
q=asind(NA)//Acceptance angle in degrees
qx=(q-int(q))*60//For output
qy=(qx-int(qx))*60//For output
N=(4.9*((d*NA)/l)^2)//Number of modes propagating through the fibre
n=(int(N)/2)//The number of modes propagating through graded fibre

//Output
printf('Refractive index of the cladding is %3.3f \n Acceptance angle of the fibre is %3.0f degrees
```

```
%3.0f minutes %3.2f seconds \n Number of modes
propagating through the fibre is %3.1f \n The
number of modes propagating through graded fibre
is %3.0f',n2,q,qx,qy,N,n)
```

Scilab code Exa 5.8 Number of modes

```
clc
clear
//Input data
l=1*10^-6//Wavelength of light used in m
n1=1.45//Refractive index of the core
n2=1.448//Refractive index of the cladding
d=6*10^-6//Diamter of the core in m

//Calculations
NA=sqrt(n1^2-n2^2)//Numerical aperture
N=4.9*(d*NA/l)^2//Number of modes propagating
    through the fibre

//Output
printf('The number of modes that can be allowed
    through the fibre is %i. \n It is a single-mode
    fibre',N)
```

Chapter 6

Geometrical Optics

Scilab code Exa 6.1 Focal length

```
clc
clear
//Input data
f=1.5//Focal length of an achromatic combination of two lenses in contact in m
dp=[0.018,0.027]//Dispersive power of the materials of the lenses

//Calculations
f12=(dp(1)/dp(2))//Ratio of dispersive powers
f1=(1-(1/f))*f//Focal length of the first lens in m
f2=(f1/-f12)//Focal length of the second lens in m

//Output
printf('Focal length of the first lens is %3.1f m (convex lens) \n Focal length of the second lens is %3.2f m (concave lens)',f1,f2)
```

Scilab code Exa 6.2 Longitudinal Chromatic aberration

```
clc
clear
//Input data
r=[0.1,0.4]//Radii of curvature in m
u=[1.5230,1.5145]//Refractive indices of the lens
   for violet and red light respectively

//Calculations
fr=1/((u(2)-1)*((1/r(1))-(1/r(2))))//Focal length of
    the lens for red light in m
fv=1/((u(1)-1)*((1/r(1))-(1/r(2))))//Focal length of
    the lens for violet light in m
f=fr-fv//Longitudinal chromatic aberration in m

//Output
printf('Longitudinal chromatic aberration for an
   object at infinity is %3.4f m',f)
```

Scilab code Exa 6.3 Dispersive power

```
clc
clear
//Input data
C=[1.5145,1.5170,1.5230]//Refractive index of the
   crown glass for C,D and F line respectively
F=[1.6444,1.6520,1.6637]//Refractive index of the
   flint glass for C,D and F line respectively

//Calculations
w1=(C(3)-C(1))/(C(2)-1)//Dispersive power of the
   first lens
w2=(F(3)-F(1))/(F(2)-1)//Dispersive power of the
   second lens

//Output
```

```
printf('The dispersive power for crown glass is %3.4
    f \n The dispersive power for the flint glass is
    %3.5f',w1,w2)
```

Scilab code Exa 6.4 Time of exposure

```
clc
clear
//Input data
t1=30//Exposure time in s
d1=5.6//Lens aperture
d2=8//Lens aperture

//Calculations
f=1/2//The squares of the f-number are in the ratio
    1:2
t2=(1/f)*t1//Exposure time in s

//Output
printf('The time of exposure is %3.0f s when the
    print is made with a lens aperture of %i',t2,d2)
```

Chapter 7

Acoustics

Scilab code Exa 7.1 Intensity level

```
clc
clear
//Input data
I=0.1//Intensity of sound produced by thunder in W/m
    ^2

//Calculations
b=10*log10(I/10^-12)//Relative intensity in dB

//Output
printf('The intensity level is %3.0f dB',b)
```

Scilab code Exa 7.2 Relative sound intensity

```
clc
clear
//Input data
I=(10^-4)//Intensity of sound in the street in W/m^2
```

```
 
//Calculations
b=10*log10(I/10^-12)//Relative intensity in dB

//Output
printf('The relative sound intensity is %3.0f dB',b)
```

Scilab code Exa 7.3 Acoustic intensity

```
clc
clear
//Input data
I=2//Sound intensity is doubled or Intensity ratio

//Calculations
b=10*log10(I)//Relative intensity in dB

//Output
printf('Increase in the acoustic intensity level is
   %3.2f dB',b)
```

Scilab code Exa 7.4 Intensity level of sound

```
clc
clear
//Input data
P=3.14//Power radiated in W
r=10//Distance (radius) in m
I=[100,1,10^-12]//Reference intensities in W/m^2

//Calculations
Is=P/(4*3.14*r^2)//Intensity of sound in W/m^2
b1=10*log10(Is/I(1))//Relative intensity in dB
```

```
b2=10*log10(Is/I(2))//Relative intensity in dB
b3=10*log10(Is/I(3))//Relative intensity in dB

//Output
printf('The intensity level of a sound with reference to \n (i) %i W/m^2 = %3.4f dB \n (ii) %i W/m^2 = %3.4f dB \n (iii) 10^-12 W/m^2 = %3.3f dB',I(1),b1,I(2),b2,b3)
```

Scilab code Exa 7.5 Intensity level

```
clc
clear
//Input data
P=1.5//The acoustic power produced by the loudspeaker in J/s
r=20//Distance in m

//Calculations
I=(P/(4*3.14*r^2))//Intensity of the sound produced by the loudspeaker in W/m^2
b=10*log10(I/10^-12)//Intensity level in dB

//Output
printf('The intensity level at a distance of %i m is %3.1f dB',r,b)
```

Scilab code Exa 7.6 Intensity level

```
clc
clear
//Input data
```

```
b1=80//Intensity levelof the sound produced by the
    electric generator in dB
b2=70//Intensity level of the room in dB

//Calculations
I2=10^(b1/10)*10^-12//Intensity of the sound
    produced by the electric generator in W/m^2
I4=10^(b2/10)*10^-12//Intensity of the sound
    existing in the room in W/m^2
I=I2+I4//Total sound intensity when the generator is
     operating in W/m^2
b=10*log10(I/10^-12)//Relative intensity in dB

//Output
printf('The resultant intensity level of the sound
    is %3.3f dB',b)
```

Scilab code Exa 7.7 Reverberation time

```
clc
clear
//Input data
v=1500//Volume of hall in m^3
A1=100//Absorption of the sound by the hall in m^2 O
    .W.U or sabines
A2=100//Absorption of the sound by the audience in m
    ^2 O.W.U or sabines

//Calculations
A=A1+A2//Total absorption of sound in sabines
t1=(0.16*v)/A1//Reverberation time of the hall when
    the room is empty in s
t2=(0.16*v)/A//Reverberation time of the hall when
    the room is filled with audience in s
t=t1-t2//Change in reverberation time in s
```

```

//Output
printf('When the hall is filled with audience, the
    reverberation time is reduced to %3.1f s',t)
```

Scilab code Exa 7.8 Average absorption coefficient

```
clc
clear
//Input data
v=1000//Volume of the hall in m^3
T=2//Reverberation time in s
s=350//Area of the sound absorbing surface in m^2

//Calculations
a=(0.16*v)/(T*s)//The average absorption coefficient

//Output
printf('The average absorption coefficient of the
    room is %3.4f',a)
```

Scilab code Exa 7.9 Reverberation time

```
clc
clear
//Input data
v=2400//Volume of the hall in m^3
s=600//Seating capacity of the hall
a=[500,600,500,20,400,200]//Area or number for
    plaster ceiling, plaster walls, wood floor, wood
    doors, seats cushion, seats cane in m^2 for arae
c=[0.02,0.03,0.06,0.06,0.01,0.01]//Coefficient of
    absorption for plaster ceiling, plaster walls,
```

```
wood floor, wood doors, seats cushion, seats cane sabine/ chair
am=0.45//Absorption of each member of the audience in sabine
//Calculations
T1=a(1)*c(1)+a(2)*c(2)+a(3)*c(3)+a(4)*c(4)+a(5)*c(5)+a(6)*c(6)//Total absorption when the hall is empty in sabine
t1=(0.16*v)/T1//Reverberation time in s
T2=a(1)*c(1)+a(2)*c(2)+a(3)*c(3)+a(4)*c(4)+a(5)*am+a(6)*am//Total absorption when the hall is occupied with audience
t2=(0.16*v)/T2//Reverberation time in s

//Output
printf('The reverberation time of the hall \n (i) when it is empty = %3.3f s \n (ii) when filled with audience = %3.2f s',t1,t2)
```

Scilab code Exa 7.10 Intensity level of jet plane

```
clc
clear
//Input data
I2=100//Sound intensity in W/m^2

//Calculations
b=10*log10(I2/10^-12)//Relative intensity in dB

//Output
printf('The intensity level of the jet plane is %3.0f dB',b)
```

Chapter 8

Ultrasonics

Scilab code Exa 8.1 Fundamental frequency

```
clc
clear
t=(1*10^-3)//Thickness of the crystal in m
d=2650//Density of quartz in kg/m^3
Y=(7.9*10^10)//Youngs modulus of quartz in N/m^2

//Calculations
f=((1/(2*t))*sqrt(Y/d))/10^6//Fundamental frequency
    of the quartz crystal in Hz *10^6

//Output
printf('Fundamental frequency of the quartz crystal
    is %3.3f *10^6 Hz',f)
```

Scilab code Exa 8.2 Fundamental frequency

```
clc
clear
```

```
//Input data
t=0.005//Length of the crystal in m
Y=(7.9*10^10)//Youngs modulus in N/m^2
d=2650//Density in kgm^3

//Calculations
f1=((1/(2*t))*sqrt(Y/d))/10^5//Fundamental vibration in Hz *10^5
f2=2*f1/10//Frequency of first overcome in Hz *10^6

//Output
printf('The frequency of the fundamental note is %3.2f *10^5 Hz \n The first overtone emitted by a piezoelectric crystal is %3.3f *10^6 Hz',f1,f2)
```

Scilab code Exa 8.3 Thickness

```
clc
clear
//Input data
v=5000//Velocity of sound in steel in m/s
f=(50*10^3)//Difference between two adjacent frequencies in Hz

//Calculations
d=(v/(2*f))//Thickness of the plate in m

//Output
printf('The thickness of the steel plate is %3.2f m',d)
```

Scilab code Exa 8.4 Youngs Modulus

```
clc
clear
//Input data
//f=(2.87*10^3)/t The fundamental frequency in terms of thickness
x=(2.87*10^3)//x value from function
d=2660//Density in kg/m^3
f=1200//Frequency of vibration in kHz

//Calculations
Y=(2*2*x^2*d)/10^10//Youngs modulus in N/m^2*10^10
t=((1/(2*f*1000))*sqrt((Y*10^10)/d))/10^-3//Thickness in m*10^-3

//Output
printf('Youngs modulus of the quartz crystal is %3.2f *10^10 N/m^2 \n The thickness of the crystal is %3.2f *10^-3 m',Y,t)
```

Chapter 9

Atomic Physics

Scilab code Exa 9.1 de Broglie wavelength

```
clc
clear
//Input data
V=150//Potential difference in V
h=(6.625*10^-34)//Plancks constant in Js
m=(9.1*10^-31)//Mass of the electron in kg
e=(1.6*10^-19)//Charge of the electron in coloumbs

//Calculations
l=(h/sqrt(2*m*e*V))/10^-10//de Broglie wavelength of
    the electron in m*10^-10

//Output
printf('The de Broglie wavelength of an electron is
   %3.4f *10^-10 m',l)
```

Scilab code Exa 9.2 de Broglie wavelength

```
clc
clear
//Input data
E=0.025//Energy of the electron in MeV
e=(1.6*10^-19)//Charge of the electron in coloumbs
h=(6.625*10^-34)//Plancks constant in Js
m=(9.1*10^-31)//Mass of the electron in kg

//Calculations
E1=E*e*10^6//Energy of the electron in J
v=sqrt((2*E1)/m)//Velocity of the electron in m/s
l=(h/(m*v))/10^-10//de Broglie wavelength in angstroms

//Output
printf('The de Broglie wavelength is %3.4f angstroms',l)
```

Scilab code Exa 9.3 de Broglie wavelength

```
clc
clear
//Input data
E=1//Energy of the electron in MeV
e=(1.6*10^-19)//Charge of the electron in coloumbs
h=(6.625*10^-34)//Plancks constant in Js
m=(9.1*10^-31)//Mass of the electron in kg

//Calculations
E1=E*e*10^6//Energy of the electron in J
v=sqrt((2*E1)/m)//Velocity of the electron in m/s
l=(h/(m*v))/10^-10//de Broglie wavelength in angstroms

//Output
```

```
printf('The de Broglie wavelength is %3.5f angstroms',l)
```

Scilab code Exa 9.4 Velocity and wavelength

```
clc
clear
//Input data
V=100//Potential difference in V
e=(1.6*10^-19)//Charge of the electron in coloumbs
h=(6.625*10^-34)//Plancks constant in Js
m=(9.1*10^-31)//Mass of the electron in kg
c=(3*10^8)//Velocity of light in m/s

//Calculations
v=sqrt((2*e*V)/m)/10^6//Velocity of the electron in m/s*10^6
u=(c^2/(v*10^6))/10^10//Phase velocity of the electron in m/s *10^10
l=(h/(m*(v*10^6)))/10^-10//de Broglie wavelength in angstroms
p=(m*(v*10^6))/10^-24//Momemtum of the electron in kg.m/s *10^-24
V1=(1/(l*10^-10))/10^9//Wave number of the electron wave in m^-1

//Output
printf('(i) Velocity of the electron is %3.5f*10^6 m/s \n (ii) Phase velocity of the electron is %3.4f*10^10 m/s  \n (iii) de Broglie wavelength is %3.5f angstroms \n (iv) Momemtum of the electron is %3.6f *10^-24 kg.m/s \n (v) Wave number of the electron wave is %3.6f *10^9 m^-1',v,u,l,p,V1)
```

Scilab code Exa 9.5 Uncertainity in momentum

```
clc
clear
//Input data
r=10^-14//Radius of the nucleus in m
m=(1.67*10^-27)//Mass of the proton in kg
h=(6.625*10^-34)//Plancks constant in Js

//Calculations
x=6.24150934*10^12//1 Joule  in MeV
dp=(h/(2*3.14*r))/10^-20//The uncertainity in the
    momentum of the proton in kg m/s *10^-20
ke=((dp*10^-20)^2/(2*m))*x//Minimum kinetic energy
    of the proton in MeV

//Output
printf('The uncertainity in the momentum of the
    proton is %3.3f*10^-20 kg m/s \n Minimum kinetic
    energy of the proton is %3.3f MeV',dp,ke)
```

Scilab code Exa 9.6 Uncertainity in momentum

```
clc
clear
//Input data
dx=(0.1*10^-10)//The uncertainity in the position of
     the electron in m
h=(6.625*10^-34)//Plancks constant in Js

//Calculations
```

```
dp=(h/(2*3.14*dx))/10^-23//The uncertainity in the momentum of the electron located in kg m/s*10^-23

//Output
printf('The uncertainity in the momentum of the electron located is %3.3f*10^-23 kg m/s',dp)
```

Scilab code Exa 9.7 Energy

```
clc
clear
//Input data
a=(1*10^-10)//Width of the potential well in m
m=(9.1*10^-31)//Mass of the electron in kg
h=(6.625*10^-34)//Plancks constant in Js

//Calculations
x=6.24150934*10^18//1 Joule in eV
E1=((h^2*1^2)/(8*m*a^2))*x//The energy of the first excited state in eV
E2=((h^2*2^2)/(8*m*a^2))*x//The energy of the second excited state in eV
E3=((h^2*3^2)/(8*m*a^2))*x//The energy of the third excited state in eV

//Output
printf('The energy of the first excited state is %3.3f eV \n The energy of the second excited state is %3.3f eV \n The energy of the third excited state is %3.3f eV',E1,E2,E3)
```

Chapter 10

Nuclear Physics

Scilab code Exa 10.1 Energy released

```
clc
clear
//Input data
mU235=235.044//Mass of U235 in a.m.u
mXe135=134.907//Mass of Xe135 in a.m.u
mMo98=97.906//Mass of Mo98 in a.m.u
mn=1.008665//Mass of neutron in a.m.u

//Calculations
LHS=mU235+mn//The total mass of the reactants in a.m
    .u
RHS=mMo98+mXe135+3*mn//The total mass of the
    products in a.m.u
md=LHS-RHS//Mass defect in a.m.u
E=(md*934.18)//Energy released in MeV

//Output
printf('The energy released in the nuclear fission
    reaction is %3i MeV',E)
```

Scilab code Exa 10.2 Energy released

```
clc
clear
//Input data
E=200//Energy released in the fission of U235 in MeV
e=1.6*10^-19//Charge of electron in Coulumb
A=6.023*10^23//Avagadros number
a=235//U235

//Calculations
x=(A/a)//Number of atoms in 1 gram of U235
E=((x*E*e*10^6)/(3.6*10^6))/10^4//Energy released by
    1 gm of U235 in kWh

//Output
printf('Energy released by 1 gm of U235 is %3.2f
    *10^4 kWh',E)
```

Scilab code Exa 10.3 Number of nuclei

```
clc
clear
//Input data
Ef=200//Energy released per fission in MeV
Er=32*10^6//Energy produced by the reactor in W
e=1.6*10^-19//Charge of electron in Coulumb

//Calculations
n=(Er/(Ef*10^6*e))/10^18//Number of U235 nuclei
    needed to produce an energy of 32*10^6 J/s *10^18

```

```
//Output
printf('%3.0f*10^18 U235 nuclei are needed to
    produce an energy of 32*10^6 J/s',n)
```

Scilab code Exa 10.4 Reactor consumption

```
clc
clear
//Input data
E=100*10^3//Energy produced by the reactor in W
e=1.6*10^-19//Charge of electron in Coulumb
A=6.023*10^23//Avagadros number
a=235//U235

//Calculations
Er=200//Let the energy released per fission be 200
    MeV,
n=(E/(Er*10^6*e))//The number of U235 nuclei needed
    to produce 100kW of energy
m=((a*n)/(A*1000))/10^-9//Mass of 'n' atoms of U235

//Output
printf('The reactor consumes %3.5f*10^-9 kg of U235
    in one second',m)
```

Scilab code Exa 10.5 Amount of fuel

```
clc
clear
//Input data
n=30//Efficiency of the reactor in percent
Ef=200//Energy released per fission in MeV
E=200//Energy needed to the city in MW
```

```
e=1.6*10^-19//Charge of electron in Coulumb
A=6.023*10^23//Avagadros number
a=235//U235

//Calculations
E1=E*10^6//Energy required to the city in J/s
E2=E1*24*60*60//Energy required to the city for one day in J
I=(E2/n)*100//Useful input in J
Ef2=(Ef*10^6*e)//Energy released per fission in J
n=(I/Ef2)//Number of nucei required to produce 'I' J of energy
m=((a*n)/(A*1000))//Mass of 'n' atoms of U235 in kg

//Output
printf('The amount of fuel required for one day operation of he reactor is %3.4f kg',m)
```

Scilab code Exa 10.6 Reactor consumption

```
clc
clear
//Input data
mH=2.01478//Mass of Hydrogen (1H2) in a.m.u
mHe=4.00388//Mass of Helium (He4) in a.m.u
n=20//Efficiency in percent
O=10000//Output of the reactor in kW
e=1.6*10^-19//Charge of electron in Coulumb
A=6.023*10^23//Avagadros number

//Calculations
md=(2*mH-mHe)//Mass defect in a.m.u
E=(md*931.48)//Energy released in MeV
O1=(O*1000)//Output of the reactor in J/s
E1=(O1*24*60*60)//Energy released by the reactor in
```

```
one day in J
I=(E1/n)*100//Useful input in J
N=(I*2/(E*10^6*e))//Number of deuterons required to release an energy of 'I' J
m=((2*N)/A)//Mass of 'N' atoms of 1H2 in gm

//Output
printf('The reactor consumes %3.3f*10^-3 kg of deuteron in one day',m)
```

Scilab code Exa 10.7 Total energy released

```
clc
clear
//Input data
mH1=1.007825//Mass of 1H1 in a.m.u
mH2=2.014102//Mass of 1H2 in a.m.u
mHe3=3.01603//Mass of 2He3 in a.m.u
mHe4=4.002603//Mass of 2He4 in a.m.u

//Calculations
//For Eq.(i)
md1=(2*mH1)-mH2//Mass defect in a.m.u. Mass defect in the textbook is wrong since 2*1.007825 is taken as 2.014650 instead of 2.015650
E1=md1*931.48//Energy released in MeV

//For Eq.(ii)
md2=(mH1+mH2)-mHe3//Mass defect in a.m.u
E2=md2*931.48//Energy released in MeV

//For Eq.(iii)
md3=(2*mHe3-mHe4-2*mH1)//Mass defect in a.m.u. Mass defect in the textbook is wrong since 2*1.007825 is taken as 2.014650 instead of 2.015650
```

```
E3=md3*931.48//Energy released in MeV

E=(E1+E2+E3)//Total energy released in the above
    reactions in MeV

//Output
printf('Total energy released in the above reactions
     is %3.4f MeV',E)
```

Chapter 11

X rays

Scilab code Exa 11.1 Shortest wavelength

```
clc
clear
//Input data
h=6.625*10^-34//Plancks constant in J.s
e=(1.6*10^-19)//Charge of the electron in C
c=(3*10^8)//Velocity of light in m/s
V=(10*10^3)//Potential difference applied in V

//Calculations
lmin=(12400/V)//The wavelength of X-rays emitted in
    angstroms
v=(c/(lmin*10^-10))/10^18//Frequency of the X-ray
    beam emitted in Hz*10^18

//Output
printf('The shortest wavelength of X-rays produced
    by an X-ray tube is %3.2f angstroms \n The
    frequency of the X-ray beam emitted is %3.3f
    *10^18 Hz',lmin,v)
```

Scilab code Exa 11.2 Number of electrons

```
clc
clear
//Input data
V=10*1000//Potential difference applied in V
I=2*10^-3//Current in A
e=(1.6*10^-19)//Charge of the electron in C
m=9.1*10^-31//Mass of the electron in kg

//Calculations
n=(I/e)/10^16//Number of electrons striking the
    target per second *10^16
v=sqrt((2*e*V)/m)/10^7//Velocity of the electron in
    m/s*10^7
lmin=12400/V//Wavelength of the X-rays in angstroms

//Output
printf('Number of electrons striking the target per
    second is %3.2f*10^16 \n Velocity of the electron
    is %3.2f*10^7 m/s \n Wavelength of the X-rays is
    %3.2f angstroms',n,v,lmin)
```

Scilab code Exa 11.3 wavelength

```

clc
clear
//Input data
d=5.6534*10^-10//Interplanar spacing in m
q1=13.666//Glacing angle in degrees
n1=1//Order of diffraction
```

```
n2=2//Order of diffraction

//Calculations
l=((2*d*sind(q1))/n1)/10^-10//Wavelength in m*10^-10
q2=asind((n2*l*10^-10)/(2*d))//Angle for the second order in degrees
qzx=(q2-(int(q2)))*60//For output
qzy=(qzx-(int(qzx)))*60//For output

//Output
printf('(a) The wavelength of the X-rays is %3.3f *10^-10 m \n (b) The angle for the second order Bragg reflection is %3.0f degrees %3.0f minutes %3.2f seconds',l,q2,qzx,qzy)
```

Scilab code Exa 11.4 Grating spacing

```

clc
clear
//Input data
V=24800//Potential difference applied in V
n=1//Order of diffraction
l=1.54*10^-10//Wavelength of X-ray beam in m
q=15.8//Glancing angle in degrees

//Calculations
d=((n*l)/(2*sind(q)))/10^-10//Interplanar spacing in m
lmin=12400/V//Minimum wavelength of X-rays emitted in angstroms
q=asind((n*lmin*10^-10)/(2*d*10^-10))//Glancing angle for minimum wavelength in degrees
qx=(q-int(q))*60//For output
qy=(qx-int(qx))*60//For output
```

```
//Output
printf('The grating spaing for NaCl crystal is %3.3f
    angstroms \n Glancing angle for minimum
   wavelength is %3.0f degrees %3.0f minutes %3.0f
   seconds',d,q,qx,qy)
```

Scilab code Exa 11.5 wavelength

```
clc
clear
//Input data
l=0.7078//Wavelength of X-rays in m
ZMo=42//Atomic number of molybdenum
ZCd=48//Atomic number of cadmium

//Calculations
lCd=(l)*((ZMo-1)^2/(ZCd-1)^2)//Wavelength of Cadmium
    radiation in angstroms

//Output
printf('The wavelength of cadmium radiation is %3.4f
    angstroms',lCd)
```

Scilab code Exa 11.6 Compton Shift

```
clc
clear
//Input data
q=60//Angle of scattering in degrees
l=1.24//Wavelength of X-rays in angstroms
m=9.1*10^-31//Mass of the electron in kg
h=6.625*10^-34//Plancks constant in J.s
```

```
c=(3*10^8)//Velocity of light in m/s

//Calculations
dl=((h*(1-cosd(q)))/(m*c))/10^-10//The Compton angle
    in degrees

//Output
printf('The Compton shift is %3.3f angstroms',dl)
```

Scilab code Exa 11.7 wavelength and energy

```
clc
clear
//Input data
l=0.112*10^-9//Wavelength of X-rays in m
q=90//Angle of scattering in degrees
m=9.1*10^-31//Mass of the electron in kg
h=6.625*10^-34//Plancks constant in J.s
c=(3*10^8)//Velocity of light in m/s

//Calculations
dl=((h*(1-cosd(q)))/(m*c))/10^-10//The Compton angle
    in degrees
l1=(dl+(l/10^-10))//Wavelength of the X-rays
   scattered at an agle of 90 degrees in angstroms
dE=((h*c*((1/l)-(1/(l1*10^-10)))))/10^-17//The
   energy of the recoiling electron in J*10^-17

//Output
printf('(a) Wavelength of the X-rays scattered at an
    agle of 90 degrees with respect to the original
   direction is %3.3f angstroms \n (b) The energy of
    the scattering electron after the collision is
   %3.2f*10^-17 J',l1,dE)
```

Chapter 12

Quantum Theory of Radiation and Photoelectric Effect

Scilab code Exa 12.1 Wavelength

```
clc
clear
//Input data
E=10//Energy of the photon in eV
h=6.625*10^-34//Plancks constant in J.s
c=3*10^8//Velocity of light in m/s
e=1.6*10^-19//Charge of electron in Columbs

//Calculations
l=((h*c)/(E*e))/10^-10//Wavelength of the photon in
    angstroms

//Output
printf('The wavelength of the photon is %3.0f
    angstroms',l)
```

Scilab code Exa 12.2 Momentum of photons

```
clc
clear
//Input data
E=3//Energy of photon in eV
c=3*10^8//Velocity of light in m/s
e=1.6*10^-19//Charge of electron in Columbs

//Calculations
p=((E*e)/c)/10^-27//The momentum of the photon in kg
    .m/s

//Output
printf('The momentum of the photon is %3.1f*10^-27
    kg.m/s',p)
```

Scilab code Exa 12.3 Number of photons

```
clc
clear
//Input data
l=6*10^-7//Wavelength of the photon in m
P=2//Power of lamp in W
h=6.625*10^-34//Plancks constant in J.s
c=3*10^8//Velocity of light in m/s

//Calculations
E=((h*c)/l)/10^-19//Energy of photon in J*10^-19
n=(P/(E*10^-19))/10^18//The number of photons
    emitted per second*10^18

//Output
printf('The number of photons emitted per second is
    %3.4f*10^18',n)
```

Scilab code Exa 12.4 Number of photons

```
clc
clear
//Input data
l=1*10^-10//Wavelength of the x-ray in m
P=1*1000//Output power in W
h=6.625*10^-34//Plancks constant in J.s
c=3*10^8//Velocity of light in m/s

//Calculations
E=((h*c)/l)/10^-15//Energy of the photon in J*10^-15
n=(P/(E*10^-15))/10^17//The number of photons emitted per second*10^17

//Output
printf('The number of photons emitted per second is %3.4f*10^17',n)
```

Scilab code Exa 12.5 Threshold Wavelength

```
clc
clear
//Input data
W=2.2//Work function of sodium in eV
h=6.625*10^-34//Plancks constant in J.s
c=3*10^8//Velocity of light in m/s
e=1.6*10^-19//Charge of electron in Columbs

//Calculations
v=(W*e)/h//Frequency in Hz
```

```
l=(c/v)/10^-10//The threshold wavelength in angstroms

//Output
printf('The threshold wavelength of the metal is %3.0f angstroms',l)
```

Scilab code Exa 12.6 Kinetic Energy

```
clc
clear
//Input data
W=3.6//Work function of zinc in eV
l=2000*10^-10//Wavelength of light used in m
h=6.625*10^-34//Plancks constant in J.s
c=3*10^8//Velocity of light in m/s
e=1.6*10^-19//Charge of electron in Columbs
m=9.1*10^-31//Mass of the electron in kg

//Calculations
lo=((h*c)/(W*e))//Threshold wavelength of zinc in m
KE=((h*c*(lo-l))/(lo*l*e))//Kinetic energy of the photoelectrons in eV
v=(sqrt((2*KE*e)/m))/10^5//Velocity of photoelectrons in m/s*10^5

//Output
printf('The kinetic energy of the photoelectrons emitted is %3.2f eV \n The velocity of the ejected photoelectrons is %3.2f*10^5 m/s',KE,v)
```

Scilab code Exa 12.7 Photoelectric work function

```
clc
clear
//Input data
lo=3200*10^-10//Threshold wavelength in m
h=6.625*10^-34//Plancks constant in J.s
c=3*10^8//Velocity of light in m/s
e=1.6*10^-19//Charge of electron in Columbs

//Calculations
W=((h*c)/(lo*e))//Work function of platinum in eV

//Output
printf('The photoelectric workfunction for platinum
    is %3.4f eV',W)
```

Scilab code Exa 12.8 Energy of photoelectrons

```
clc
clear
//Input data
lo=6000*10^-10//Threshold wavelength in m
l=3600*10^-10//Wavelength of the light used in m
h=6.625*10^-34//Plancks constant in J.s
c=3*10^8//Velocity of light in m/s
e=1.6*10^-19//Charge of electron in Columbs

//Calculations
E=(h*c*((1/l)-(1/lo)))/e//Energy of the
    photoelectrons emitted in eV

//Output
printf('Energy of the photoelectrons emitted is %3.2
    f eV',E)
```

Scilab code Exa 12.9 Stopping Potential

```
clc
clear
//Input data
W=1.9//Work function in eV
E=3//Energy of the emitted photons in eV

//Calculations
V=(E-W)//Stopping potential in V

//Output
printf('The stopping potential is %3.1f V',V)
```

Scilab code Exa 12.10 Threshold frequency

```
clc
clear
//Input data
W=2.4//Work function in eV
l=6000*10^-10//Wavelength of the light in m
h=6.625*10^-34//Plancks constant in J.s
c=3*10^8//Velocity of light in m/s
e=1.6*10^-19//Charge of electron in Columbs

//Calculations
vo=((W*e)/h)/10^14//Threshold frequency in Hz*10^14
v=(c/l)/10^14//Frequency of incident light in Hz*10^14

//Output
```

```
printf('Threshold frequency is %3.3f*10^14 Hz and
   Frequency of incident light is %i*10^14 Hz \n
   Since v<vo the photoelectric effect is not
   possible',vo,v)
```

Scilab code Exa 12.11 Kinetic Energy

```
clc
clear
//Input data
l=2500*10^-10//Wavelength of light used in m
W=4.2//Workfunction of aluminium in eV
h=6.625*10^-34//Plancks constant in J.s
c=3*10^8//Velocity of light in m/s
e=1.6*10^-19//Charge of electron in Columbs

//Calculations
KE=((h*c/l)-(W*e))/10^-19//Kinetic energy of the
   photoelectron in J*10^-19
Vs=(KE*10^-19/e)//Stopping potential in V

//Output
printf('The K.E of the fastest moving electron is %3
   .2f*10^-19 J \n The stopping potential is %3.5f V
   ',KE,Vs)
```

Chapter 13

Crystallography

Scilab code Exa 13.2 Lattice constant

```
clc
clear
//Input data
d=9.6*10^2//Density of sodium in kg/m^3
a=23//Atomic weight of sodium
n=2//Number of atoms present in one unit cell in bcc
    crystal
x=6.023*10^26//Avagadro constant per kg mole

//Calculations
m=(n*a)/x//Mass of one unit cell in kg
a1=(m/d)^(1/3)/10^-10//Lattice constant of sodium
   angstroms

//Output
printf('The lattice constant for sodium crystal is
   %3.1f angstroms',a1)
```

Scilab code Exa 13.3 Avagadro Constant

```
clc
clear
//Input data
d=4*10^3//Density of CsCl in kg/m^3
a1=132.9//Atomic weight of Cs
a2=35.5//Atomic weight of Cl
a=(4.12*10^-10)//Lattice constant in m

//Calculations
m=(d*a^3)//Mass of the CsCl unit cell in kg
N=((a1+a2)/m)/10^26//Avagadro number in 10^26 per kg
    mole

//Output
printf('The value of the Avagadro constant is %3.4f
   *10^26 per kg mole',N)
```

Scilab code Exa 13.5 Miller Indices

```
clc
clear
//Input data
x=2//Lattice plane cut intercepts of length 2a
y=3//Lattice plane cut intercepts of length 3b
z=4//Lattice plane cut intercepts of length 4c

//Calculations
x1=1/x//Inverse of coefficients
y1=1/y//Inverse of coefficients
z1=1/z//Inverse of coefficients
LCM=12//L.C.M of x,y,z
x2=(x1*LCM)//Multiplying the fractions by LCM
y2=(y1*LCM)//Multiplying the fractions by LCM
z2=(z1*LCM)//Multiplying the fractions by LCM

```

```
//Output
printf('The miller indices of the plane is (%i %i %i
    )',x2,y2,z2)
```

Scilab code Exa 13.6 Length of intercepts

```
clc
clear
//Input data
p=[1.2,1.8,2]//Primitives of the crystal in
    angstroms
m=[2,3,1]//Miller indices of the plane
x=1.2//Intercept made by the plane along the X-axis

//Calculations
mx1=1/m(1)//Inverse of the miller indices
mx2=1/m(2)//Inverse of the miller indices
mx3=1/m(3)//Inverse of the miller indices
my1=mx1*6//Multiplying with the L.C.M
my2=mx2*6//Multiplying with the L.C.M
my3=mx3*6//Multiplying with the L.C.M
x1=my1*p(1)//Multiplying with the primitives of the
    crystal
x2=my2*p(2)//Multiplying with the primitives of the
    crystal
x3=my3*p(3)//Multiplying with the primitives of the
    crystal
l2=(x*x2)/x1//Length of intercept along Y axis
l3=(x*x3)/x1//Length of intercept along Z axis

//Output
printf('The length of the intercepts made by the
    plane along Y and Z axes are %3.1f angstroms and
    %i angstroms',l2,l3)
```

Scilab code Exa 13.7 intercepts

```
clc
clear
//Input data
m=[1,1,0]//Miller indices of the plane

//Calculations
x=1/m(1)//Inverse of the miller indices
y=1/m(2)//Inverse of the miller indices
z=%inf//Inverse of the miller indices, since 1/0 is
   infinity

//Output
disp('The intercepts made by the given plane along
   the Z axis is infinity. It means that the plane
   is parallel to the Z axis')
```

Scilab code Exa 13.8 Lattice spacing

```
clc
clear
//Input data
a=4.12*10^-10//Lattice constant in m
p1=[1,1,1]//Miller indices of the plane 1
p2=[1,1,2]//Miller indices of the plane 2
p3=[1,2,3]//Miller indices of the plane 3

//Calculations
d11=(a/sqrt(p1(1)^2+p1(2)^2+p1(3)^2))/10^-10//The
   lattice spacing for the plane in m*10^-10
```

```
d12=(a/sqrt(p2(1)^2+p2(2)^2+p2(3)^2))/10^-10//The lattice spacing for the plane in m*10^-10
d13=(a/sqrt(p3(1)^2+p3(2)^2+p3(3)^2))/10^-10//The lattice spacing for the plane in m*10^-10

//Output
printf('The lattice spacing for the planes (%i %i %i) is %3.4f*10^-10 m \n The lattice spacing for the planes (%i %i %i) is %3.4f*10^-10 m \n The lattice spacing for the planes (%i %i %i) is %3.4f*10^-10 m',p1(1),p1(2),p1(3),d11,p2(1),p2(2),p2(3),d12,p3(1),p3(2),p3(3),d13)
```

Scilab code Exa 13.9 Seperation between planes

```
clc
clear
p1=[1,0,0]//Miller indices of the plane 1
p2=[1,1,0]//Miller indices of the plane 2
p3=[1,1,1]//Miller indices of the plane 3

d11=(1/sqrt(p1(1)^2+p1(2)^2+p1(3)^2))//The lattice spacing for the plane in m* a
d12=(1/sqrt(p2(1)^2+p2(2)^2+p2(3)^2))//The lattice spacing for the plane in m* a
d13=(1/sqrt(p3(1)^2+p3(2)^2+p3(3)^2))//The lattice spacing for the plane in m* a

//Output
printf('The seperation between the successive plane (%i %i %i), (%i %i %i) and (%i %i %i) are in the ratio of %3.0f : %3.2f : %3.2f',p1(1),p1(2),p1(3),p2(1),p2(2),p2(3),p3(1),p3(2),p3(3),d11,d12,d13)
```

Chapter 14

Engineering Materials

Scilab code Exa 14.1 Lorentz number

```
clc
clear
s=5.87*10^7//Electrical conductivity of Cu in ohm
    ^-1.m^-1
K=390//Thermal conductivity of Cu in W/m.K
T=(20+273)//Temperature in K

//Calculations
L=(K/(s*T))/10^-8//Lorentz number in W.ohm/K^2

//Calculations
printf('Lorentz number is %3.3f*10^-8 W.ohm/K^2',L)
```

Scilab code Exa 14.2 Electrical conductivity

```
clc
clear
//Input data
```

```
t=10^-14//Relaxation time in s
T=300//Temperature in K
n=6*10^28//Electron concentration in m^-3
e=1.6*10^-19//Electron charge in Columbs
m=9.1*10^-31//Mass of electron in kg
kB=1.38*10^-23//Boltzmann constant in J/K

//Calculations
s=((n*e^2*t)/m)/10^7//Electrical conductivity in ohm
    ^-1.m^-1 *10^7
K=((n*3.14^2*kB^2*T*t)/(3*m))//Thermal conductivity
    in W/m.K
L=(K/(s*10^7*T))/10^-8//Lorentz number in W.ohm/K^2
    *10^-8

//Output
printf('Electrical conductivity is %3.4f*10^7 ohm
    ^-1.m^-1 \n Thermal conductivity is %3.4f W/m.K \
    n Lorentz number is %3.4f*10^-8 W.ohm/K^2',s,K,L)
```

Scilab code Exa 14.3 Electrical conductivity

```
clc
clear
//Input data
d=8900//Density of copper in kg/m^3
a=63.5//Atomic weight of Cu
t=10^-14//Relaxation time in s
A=6.023*10^26//Avagadro number per mole
e=1.6*10^-19//Electron charge in Columbs
m=9.1*10^-31//Mass of electron in kg

//Calculations
n=(A*d)/a//Concentration of free electrons in m^-3
s=((n*e^2*t)/m)/10^7//Electrical conductivity in ohm
```

```
    ^-1.m^-1 *10^7

//Output
printf('The electrical conductivity is %3.4f*10^7
    ohm^-1.m^-1',s)
```

Scilab code Exa 14.4 Relaxation time

```
clc
clear
//Input data
r=1.54*10^-8//Resistivity in ohm.m
Ef=5.5//Fermi energy in eV
n=5.8*10^28//Concentration of electrons in m^-3
E=100//Electric field applied n V/m
e=1.6*10^-19//Electron charge in Columbs
m=9.1*10^-31//Mass of electron in kg

//Calculations
t=(m/(r*n*e^2))/10^-14//Relaxation time in s*10^-14
u=((e*t*10^-14)/m)/10^-3//Mobility of the electron
    in m^2.V^-1.s^-1*10^-3
v=(e*t*10^-14*E)/m//Drift velocity in m/s
vf=(sqrt((2*Ef*e)/m))/10^6//Fermi velocity in m/s
    *10^6
l=(vf*10^6*t*10^-14)/10^-8//Mean free path in m
    *10^-8

//Output
printf('The relaxation time of electrons is %3.2f
    *10^-14 s \n The mobility of the electrons is %3
    .2f*10^-3 m^2.V^-1.s^-1 \n The drift velocity of
    electrons is %3.3f m/s \n The fermi velocity of
    electrons is %3.2f*10^6 m/s \n The mean free path
     is %3.2f*10^-8 m',t,u,v,vf,l)
```

Scilab code Exa 14.5 Energy stored in the capacitor

```
clc
clear
//Input data
C=(2*10^-6)//Capacitance in F
er=80//Permitivity of the dielectric
V=1000//Applied voltage in V

//Calculations
E1=(1/2)*C*V^2//Energy stored in the capacitor in
    Joule
Co=C/er//Capacitance of the capacitor when the
    dielectric is removed in F
E2=(1/2)*Co*V^2//Energy stored in the capacitor with
     vacuum as dielectric in J
E=E1-E2//Energy stored in the capacitor in
    polarizing the dielectric in J

//Output
printf('Energy stored in the capacitor is %i J \n
    The energy stored in the capacitor in polarizing
    the capacitor is %3.4f J',E1,E)
```

Scilab code Exa 14.6 Ratio of internal field to applied field

```
clc
clear
//Input data
N=5*10^28//Number of atoms present per m^3
a=2*10^-40//polarizability in F.m^2
```

```
eo=8.854*10^-12//permittivity of free space in F/m

//Calculations
E=1/(1-((N*a)/(3*eo)))//Ratio of the internal field to the applied field

//Output
printf('Ratio of the internal field to the applied field is %3.4f',E)
```

Scilab code Exa 14.7 Magnetizing force

```
clc
clear
//Input data
M=2300//Magnetization in A/m
B=0.00314//Flux density in Wb/m^2
uo=(4*3.14)*10^-7//Permeability of free space in H/m

//Calculations
H=(B/uo)-M//Magnetizing force in A/m
ur=(M/H)+1//Relative permeability

//Output
printf('The magnetizing force is %3.0f A/m \n The relative permeability is %3.1f',H,ur)
```

Scilab code Exa 14.8 Magnetization

```
clc
clear
//Input data
H=10^4//Magnetic field intensity in A/m
```

```
s=3.7*10^-3//Susceptibility
uo=(4*3.14)*10^-7//Permeability of free space in H/m

//Calculations
M=s*H//Magnetization n A/m. The textbook answer is
    given as 370 A/m which is wrong.
B=(uo*(M+H))/10^-2//Flux density in Wb/m^2 *10^-2

//Output
printf('Magnetization in the material is %3.0f A/m \
   n The flux density in the material is %3.5f*10^-2
    Wb/m^2',M,B)
```

Scilab code Exa 14.9 Average Magnetization

```
clc
clear
//Input data
a=2.5*10^-10//Interatomic spacing in m
M=(1.8*10^6)//Magnetization in Wb/m^2
n=2//Number of atoms per unit cell in bcc crystal
e=1.6*10^-19//Electron charge in Columbs
m=9.1*10^-31//Mass of electron in kg
h=6.625*10^-34//Plancks constant in J.s

//Calculations
N=(n/a^3)//Number of atoms present per unit volume
    in m^-3
m1=(M/N)//Total magnetization produced per atom in A
    /m^2
b=(e*h)/(4*3.14*m)//Bohr magnetron
M1=(m1/b)//Magnetization produced per atom in Bohr
    magnetron

//Output
```

```
printf('The average magnetization contributed per
    atom is %3.6f Bohr magneton',M1)
```

Chapter 15

Photoelasticity

Scilab code Exa 15.1 Difference between refractive indices

```
clc
clear
//Input data
d=10*10^8//Difference between the principal stress
    in N/m^2
c=(1*10^-12)//Stress-optic coefficient in m^2/N

//Calculations
N=(c*d)//Difference between the refractive indices

//Output
printf('The difference between the refractive
    indices along the principal stresses is %3.3f',N)
```

Scilab code Exa 15.2 Maximum shearing stress

```
clc
clear
```

```
//Input data
s1=(405*10^6)//Principal stress in N/m^2
s2=(-105*10^6)//Principal stress in N/m^2

//Calculations
tmax=((s1-s2)/2)/10^6//Maximum shearing stress in N/m^2 *10^6

//Output
printf('The maximum shearing stress is %3.0f*10^6 N/m^2',tmax)
```

Chapter 16

Thermal Physics

Scilab code Exa 16.1 Temperature of the body

```
clc
clear
//Input data
T1=(75+273)//Initial temperature in K
T2=(60+273)//Final temperature in K
T0=(30+273)//Surrounding temperature in K
t1=(5*60)//Time taken by the liquid to cool from 75
   degrees C to 60 degrees C

//Calculations
T3=(T2-T0)^2/(T1-T0)+T0//The temperature of the body
    after the next 5 minutes in K

//Output
printf('The temperature of the body after the next 5
    minutes is %3.0f K',T3)
```

Scilab code Exa 16.2 Specific heat

```
clc
clear
//Input data
T1=(50+273)//Initial temperature of the liquid in K
M1=0.1//Mass of water in kg
T2=(40+273)//Final temperature of the liquid in K
t1=(5*60)//Time taken by the water to cool from 50 degrees C to 40 degrees C
M2=0.085//Mass of the liquid in kg
M=0.1//Mass of the calorimeter in kg
t2=(2*60)//Time taken by the liquid to cool from 50 degrees C to 40 degrees C
S=385//Specific heat of the calorimeter in J/kg.K
S1=4190//Specific heat of the water in J/kg.K

//Calculations
S2=(((M1*S1+M*S)*(t2/t1))-(M*S))/M2//Specific heat of the liquid in J/kg.K

//Output
printf('Specific heat of the liquid is %3.0f J/kg.K',S2)
```

Scilab code Exa 16.3 Efficiency

```
clc
clear
//Input data
C=(11.4*10^6)//Calorific value of 1 kg of petrol in Calorie/kg
t=25//Total petrol consumed in kg
P=99.75//Power output in kW

//Calculations
C1=(t*C)//Calorific value of 25 kg of petrol in
```

```
Calorie
E=(C1*4.2)//Energy consumed by the engine in one hour in J/hour
E1=(E/3600)//Energy consumed by the engine in one second in J/s
n=((P*1000)/E1)*100//Efficiency in percent

//Output
printf('The efficiency of the engine is %i percent',n)
```

Scilab code Exa 16.4 Change in temperature

```
clc
clear
//Input data
h=60//Height of the Niagra falls in m
S=4190//Specific of water in J/kg.K

//Calculations
dt=(h*9.8)/S//The temperature difference in K

//Output
printf('The temperature difference is %3.5f K',dt)
```

Scilab code Exa 16.5 Temperature of source

```
clc
clear
//Input data
n=(1/6)//Efficiency
T=82//Temperature to which the sink is reduced in K
//Solving two equations
```

```
//5T1=6T2
//2T1=3T2-246
A=[5 -6
   2 -3]//Coefficient matrix
B=[0
   -246]//Constant matrix
X=inv(A)*B//Variable matrix

//Output
printf('The temperature of the source is %3.0f K \n The temperature of the sink is %3.0f K',X(1),X(2))
```

Scilab code Exa 16.6 Heat supplied

```
clc
clear
//Input data
T=[7+273 27+273]//Temperatures between the refrigerator is working in K
W=250//Work done in J

//Calulations
Q2=(W/(T(2)-T(1)))*T(1)//Quantity of heat removed per second in J/s
Qx=(Q2*3600)/10^7//Quantity of heat removed per hour in J/h*10^7

//Output
printf('Quantity of heat removed per hour by the refrigerator is %3.2f*10^7 J/h',Qx)
```

Chapter 17

Thermal conduction

Scilab code Exa 17.1 Thermal conductivity

```
clc
clear
//Input data
m=0.8//Mass of the slab in kg
l=(9.648*10^-3)//Thickness of slab in m
d=(1.464*10^-3)//Thickness of the cardboard in m
r=(5.752*10^-2)//Radius of the slab in m
S=385//Specific heat of slab in J/kg.K
T2=363.5//Steady temperature of the slab in K
T1=372//Steady temperature of the steam chamber in K
dTt=(10/300)//Rate of cooling in K/s

//Calculations
K=(m*S*dTt*((r+2*l)/(2*r+2*l)))*(d/(3.14*r^2))*(1/(
   T1-T2))//Thermal conductivity of the cardboard in
    W/m.K

//Output
printf('Thermal conductivity of the cardboard is %3
   .4f W/m.K',K)
```

Scilab code Exa 17.2 Thermal conductivity

```
clc
clear
//Input data
L2=0.032//Length of the wax melted portion in the iron rod in m
L1=0.08//Length of the wax melted portion in the copper rod in m
K1=385//Thermal conductivity of copper in W/m.K

//Calculations
K2=(K1*L2^2)/L1^2//Thermal conductivity of iron in W/m.K

//Output
printf('Thermal conductivity of iron is %3.1f W/m.K',K2)
```

Scilab code Exa 17.3 Energy

```
clc
clear
//Input data
d=0.2//Length of iron rod in m
A=0.685*10^-4//Area of cross-section in m^2
T1=100+273//Temperature of the hot end in K
T2=30+273//Temperature of the other end in K
K=62//Thermal conductivity of iron in W/m.K
t=10*60//Time in sec

//Calculations
```

```
Q=(K*A*(T1-T2)*t)/d//Quantity of heat conducted in J

//Output
printf('The iron rod conducts %3.2f J of energy in
    10 minutes',Q)
```

Scilab code Exa 17.4 Thermal conductivity

```
clc
clear
//Input data
m=1//Mass of water collected in kg
r=0.02//Radius of bar in m
d=0.05//Distance between the thermometers in m
T1=80+273//Temperature of the thermometer 1 in K
T2=70+273//Temperature of the thermometer 2 in K
T3=30+273//Temperature of water at the inlet in K
T4=40+273//Temperature of water at the outlet in K
t=(7*60)//Time of flow in s
S=4190//Specific heat of water in J/kg.K

//Calculations
K=(m*d*(T4-T3)*S)/(3.14*r^2*t*(T1-T2))//Thermal
    conductivity of the metal in W/m.K

//Output
printf('Thermal conductivity of the metal is %3.2f W
    /m.K',K)
```

Scilab code Exa 17.5 Time taken

```
clc
clear
```

```
//Input data
x=6//Thickness of the ice layer in cm
x1=(x+0.2)//Increase in thickness in cm
K=2.1//Thermal conductivity of ice in W/m.K
L=3.36*10^5//Latent heat of ice in J/kg
d=910//Density of ice at 0 degree C in kg/m^3
T=-(273-((20+273)))//Change of temperature in K

//Calculations
t=(d*L*(x1^2-x^2)*10^-4)/(2*K*T)//Time taken by ice to increase its thickness in sec

//Output
printf('Time taken by ice to increase its thickness from %i cm to %3.1f cm is %3.2f sec',x,x1,t)
```

Scilab code Exa 17.6 Temperature at interface

```
clc
clear
//Input data
d1=0.04//Thickness of first layer in m
d2=0.02//Thickness of second layer in m
K1=226.8//Thermal conductivity of the first layer in W/m.K
K2=151.2//Thermal conductivity of the second layer in W/m.K
T1=100+273//Temperature of first layer in K
T2=0+273//Temperature of second layer in K

//Calculations
T=((((K1*T1)/d1)-((K2*T2)/d2))/((K1/d1)+(K2/d2)))//The temperature at the interface in K. The formula and calculation is made wrong in the textbook.
```

```

//Output
printf('The temperature at the interface is %3.3f K',T)
```

Scilab code Exa 17.7 Thermal gradient

```
clc
clear
//Input data
K1=0.168//Thermal conductivity of the briks in W/m.K
K2=0.042//Thermal conductivity of cork in W/m.K
d1=0.08//Thickness of the brick in m
d2=0.04//Thickness of the cork in m
T1=20+273//Outer temperature in K
T2=10+273//Inner temperature in K

//Calculations
T=((d2*K1*T1+d1*T2*K2)/(d1*K2+d2*K1))//The temperature of the interface in K
dT=(T1-T)//Difference in temperature in the bricks in K
tg=(dT/d1)//Temperature gradient in the bricks in K/m
tc=(T-T2)/d2//Temperature gradient in the cork in K/m

//Output
printf('Temperature gradient in the bricks is %3.2f K/m \n Temperature gradient in the cork is %3.2f K/m',tg,tc)
```