Scilab Textbook Companion for Engineering Physics by U. Mukherji[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

Crystallography And Crystal Imperfection

Scilab code Exa 1.1 density of metal

```
//chapter-1,Example1_1,pg 40
n=4
M=65.34
N=6.023*10^23
d111=2.08*10^-8//interplannar spacing
a=d111*sqrt((1^2)+(1^2)+(1^2))
D=(n*M)/(N*(a^3))
printf("density of Cu-metal\n")
printf("D=%.2f g/cc",D)
```

Scilab code Exa 1.2 find intercepts along crystal axis

```
//chapter-1,Example1_2,pg 40

//miller plane 231

a=1.2*10^-10

b=1.8*10^-10

c=2*10^-10//primitives of crystal

//intercepts of ABC plane

a1=a/2

b1=b/3

c1=c/1

//intercept of ABC plane along X-axis =0.6*10^-10

//ABC is not the reqd. plane

//intercept of DEF plane parallel to ABC

a2=a

b2=(2*b)/3

c2=2*c

//miller indices for DEF

```

```
//1:(3/2):(1/2)

printf("intercept of DEF plane\n")

printf("along x-axis=%.11f\n",a2)

printf("along y-axis=%.11f\n",b2)

printf("\nalong z-axis=%.11f",c2)

printf("\nDEF is the reqd. plane")
```

Chapter 2

Thermoelectricity

Scilab code Exa 2.1 `find out inversion temperature`

```
//chapter-2,Example2_1,pg 54

Tn=285

Tc1=20

Ti1=(2*Tn)-Tc1

Tc2=-20

Ti2=(2*Tn)-Tc2

printf("higher temperature\n")

printf("Ti1=%.f deg. C",Ti1)

printf("\ntemperature of inversion\n")

printf("Ti2=%.f deg. C",Ti2)
```

Scilab code Exa 2.2 thermo emf of thermocouple

```
//chapter-2,Example2_2,pg 54

aFe=16.65

aAg=2.86

bFe=-0.095

bAg=0.017

aFe_Ag=aFe-aAg

bFe_Ag=bFe-bAg

a=aFe_Ag

b=bFe_Ag

Tn=-(a/b)

t=100

EFe_Ag=(a*t)+0.5*(b*(t^2))

printf("neutral temp. of Fe-Ag thermocouple\n")

printf("Tn=%.3f deg. C",Tn)

printf("\nthermo e.m.f of thermocouple\n")

printf("EFe_Ag=%.f volts",EFe_Ag)
```

Scilab code Exa 2.3 emf of thermocouple

```
//chapter-2,Example2_3,pg 54

//P=(dE/dt)Fe=a+b*t=1734-4.87*t

//P=(dE/dt)Cu=a+b*t=136+0.95*t

aFe_Pb=1734*10^-6

aFe_Cu=(1734-136)*10^-6

aCu_Pb=136*10^-6

bFe_Pb=-4.87*10^-6

bFe_Cu=(-4.87-0.95)*10^-6

bCu_Pb=0.95*10^-6

a=aFe_Cu

b=bFe_Cu

t=100

EFe_Cu=(a*t)+0.5*(b*(t^2))

printf("e.m.f of termocouple\n")

printf("EFe_Cu=%.4f Volt",EFe_Cu)
```

Chapter 3

Thermionic Emission

Scilab code Exa 3.1 Richardson Dushman Equation

```
//chapter-3,Example3_1,pg 67

S=2*10^-6

T=2000

A=60.2*10^4

b=52400//Q/K

e=1.6*10^-19

I=A*S*(T^2)*(%e^(-(b/T)))

J=A*(T^2)*(%e^(-(b/T)))

no=J/e

printf("maximum obtainable electronic emission
    current\n")

```

```
disp(I)

printf("\nemission current density\n")

printf("J=%.3f A/m2",J)

printf("\nno. of electrons emitted per unit area per sec.\n")

disp(no)
```

Scilab code Exa 3.2 calculate plate voltage

```
//chapter-3,Example3_2,pg 67

Ip1=20*10^-3

Ip2=30*10^-3

Vp1=80

//Ip=K*(Vp^(3/2))

Vp2=((((Vp1)^(3/2))*Ip2)/Ip1)^(2/3)

printf("plate voltage for 30mA current\n")

printf("Vp2=%.2f volts",Vp2)
```

Chapter 4

Ultrasonic

Scilab code Exa 4.1 find distance between two ships

```
//chapter4,Example4_1,pg 84

V1=343

//S=V1*t1

V2=1372

//S=V2*t2

dt=3//time difference

S=((V1*V2)*(dt))/(V2-V1)

printf("distance between two ships\n")

printf("S=%.f m",S)
```

Scilab code Exa 4.2 calculate depth of sea

```
//chapter4,Example4_2,pg 84

V=1700

t=0.65

d=(V*t)/2

n=0.07*10^6

lam=V/n

printf("depth of sea\n")

printf("d=%.1f m",d)

printf("\nwavelength of pulse\n")

printf("lam=%.4f m",lam)
```

Scilab code Exa 4.3 `calculate natural frequency`

```
//chapter4,Example4_3,pg 84

P=1

l=40*10^-3

E=115*10^9

D=7.25*10^3

n=(P/(2*l))*sqrt(E/D)

printf("natural frequency\n")
```

```
printf("n=%.2f Hz",n)

printf("\nfrequency of rod is more than audible
   range, rod cannot be used in magnetostriction
   oscillator\n")
```

Chapter 5

Acoustics

Scilab code Exa 5.1 find absorption coefficient

```
//chapter5,Example5_1,pg 97

T1=1.5

T2=1

A=20

V=10*8*6

a=((0.161*V)/(2*A))*((1/T2)-(1/T1))

printf("absorption coefficient\n")

printf("a=%.3f Sabines",a)
```

Scilab code Exa 5.2 find area of wall covered by curtain

```
//chapter5,Example5_2,pg 97

V=3000

T1=3.5//reverberation time

A=(0.161*V)/T1

l=20

b=15

h=10

S=2*((l*b)+(b*h)+(h*l))

sum_a=A/S

am=0.5

a=0.106

T2=2.5//reverberation time after cloth use

S1=(((0.161*V)/(am-a))*((1/T2)-(1/T1)))

printf("area of wall covered by curtain cloth\n")

printf("S1=%.3f sq.m",S1)
```

Scilab code Exa 5.3 `find reverberation time`

```
//chapter5,Example5_3,pg 98

V=1450
```

```
A1=112*0.03//absorption due to plastered wall

A2=130*0.06//absorption due to wooden floor

A3=170*0.04//absorption due to plastd. celing

A4=20*0.06//absorption due to wooden door

A5=100*1//absorption due to cushioned chairs

sum_as=A1+A2+A3+A4+A5

T1=(0.161*V)/sum_as//reverberation time case-1

T2=(0.161*V)/(sum_as+(60*4.7))//persons=60,A=4.7
    case-2

T3=(0.161*V)/(sum_as+(100*4.7))//seat cushioned=100
    rev. case-3

printf("rev. time for case-1\n")

printf("T1=%.3f sec",T1)

printf("\nrev. time for case-2\n")

printf("T2=%.3f sec",T2)

printf("\nrev. time for case-3\n")

printf("T3=%.3f sec",T3)
```

Chapter 6

Semiconductors

Scilab code Exa 6.1 `final velocity of electron`

```
//chapter6,Example6_1,pg 121

e=1.6*10^-19

V=1000

m=9.1*10^-31

v=sqrt((2*e*V)/m)

printf("final velocity of electron\n")

printf("v=%.f m/sec",v)
```

Scilab code Exa 6.2 `find electric field`

```
//chapter6,Example6_2,pg 121

```

```
Jc=1

sig=5.8*10^7

E=(Jc)/sig

printf("electric field established\n")

disp(E)
```

Scilab code Exa 6.3 electric field intensity for silver

```
//chapter6,Example6_3,pg 121

vd=1*10^-3

sig=6.17*10^7

ue=0.0056

rhoe=-(sig/ue)

Jc1=-rhoe*vd

E1=(Jc1)/sig

I=80

A=9*10^-6

Jc2=I/A

E2=Jc2/sig

V=0.5*10^-3
```

```
d=3*10^-3

E3=V/d

printf("E-field due to Jc1\n")

printf("E1=%.6f V/m",E1)

printf("\nE-field due to Jc2\n")

printf("E2=%.6f V/m",E2)

printf("\nE-field due to cube\n")

printf("E3=%.6f V/m",E3)
```

Scilab code Exa 6.4 find current density current and power out

```
//chapter6,Example6_4,pg 122

sig=3.82*10^7

L=1000*12*2.54*10^-2//converting into m

r=0.4*2.54*10^-2

V=1.2

Jc=sig*(V/L)

A=3.14*(r^2)

Ic=Jc*A

```

```
P=Ic*V

printf("current density\n")

printf("Jc=%.f A/m2",Jc)

printf("\ntotal current\n")

printf("Ic=%.2f A",Ic)

printf("\npower dissipation\n")

printf("P=%.2f watt",P)
```

Scilab code Exa 6.5 conductivity due to holes and electrons

```
//chapter6,Example6_5,pg 122

ni=2.5*10^19

um=0.39

up=0.19

e=1.6*10^-19

L=6*10^-3

R=120

A=0.5*10^-6

sigp=L/(R*A)

p=sigp/(e*up)
```

```
Na=p

n=(ni^2)/Na

sigm=n*e*um

ratio=sigp/sigm

printf("p−type impurity concentration\n")

disp(p)

printf("\nproportion of conductivity due to hole and
    electron\n")

printf("ratio=%.f",ratio);printf(":1")
```

Scilab code Exa 6.6 calculate current due to Ge plate

```
//chapter6,Example6_6,pg 123

ni=2*10^19

e=1.6*10^-19

up=0.17

un=0.36

V=2

A=10^-4

d=0.3*10^-3
```

```
I=(ni*e*(up+un)*V*A)/d

printf("current produced in Ge-plate\n")

printf("I=%.4f A",I)
```

Scilab code Exa 6.7 find intrinsic carrier density

```
//chapter6,Example6_7,pg 123

rho=6.3*10^4

e=1.6*10^-19

up=0.14

un=0.05

ni=1/(rho*e*(up+un))

printf("intrinsic carrier concentration\n")

disp(ni)
```

Scilab code Exa 6.8 Hall Effect

```
//chapter6,Example6_8,pg 123

L=10^-3

R=1.5

```

```
A=10^-6
Ey=0.6
w=10^-3
d=10^-3
I=120*10^-3
Bz=0.05
e=1.6*10^-19
sigp=L/(R*A)
Vhp=Ey*w
Rhp=(Vhp*d)/(I*Bz)
Uhp=sigp*Rhp
theta=atan(Uhp*Bz)
theta=theta*(180/%pi)
p=1/(Rhp*e)
printf("hall voltage :Vhp=%.4f Volt\n",Vhp)
printf("\nhall coeff. :Rhp=%.5f m3/e\n",Rhp)
printf("\nhall mobility :Uhp=%.4f m2/VS\n",Uhp)
printf("\nhall angle :theta=%.2f deg.\n",theta)
printf("\ndensity of charge carrier\n")
```

```
disp(p)
```

Scilab code Exa 6.9 concentration of holes in Si

```
//chapter6,Example6_9,pg 123

n=1.4*10^24

ni=1.4*10^19

Nd=n

p=(ni^2)/Nd

nbyp=n/p

printf("electron-hole concentration ratio\n")

disp(nbyp)
```

Scilab code Exa 6.10 Hall Effect

```
//chapter6,Example6_10,pg 124

Rhp=3.66*10^-4

rho=8.93*10^-3

e=1.6*10^-19

p=1/(Rhp*e)

Uhp=Rhp/rho
```

```

Bz=0.5

theta=atan(Uhp*Bz)

theta=theta*(180/%pi)

printf("density of charge carrier\n")

disp(p)

printf("\nhall angle\n")

printf("theta=%.2f deg.",theta)

printf("\nhall mobility\n")

printf("Uhp=%.4f m2/VS",Uhp)
```

Scilab code Exa 6.11 effect of external impurity

```
//chapter6,Example6_11,pg 124

ni=2.5*10^13

e=1.6*10^-19

un=3900

up=1900

sigin=ni*e*(un+up)//intrinsic conductivity

//1 donor atom/10^8 Ge atom dropped

```

```
rhoGe=4.42*10^22//no. of Ge atom/cc

Nd=rhoGe/10^8

sigex=Nd*e*un//extrinsic conductivity

printf("extrinsic conductivity\n")

printf("sigex=%.4f ohm cm",sigex)
```

Scilab code Exa 6.12 probability of electron in CB

```
//chapter6,Example6_12,pg 124

//permeability of electron to be in C.B=F(Ec)

e=1.6*10^-19

Eg=5.6

Ef=Eg/2

Ec=Eg

K=1.38*10^-23

T=27+273//converting in Kelvin

KT=K*T

KT=KT/e

//e^(Ec-Ef/KT)>>1

Fermi_F=e^((Ef-Ec)/KT)//fermi factor
```

```
printf("probability of electron on CB\n")

disp(Fermi_F)

printf("\nit is infinite in negative direction for
   an insulator like diamond, so diamond cannot take
    part in conduction")
```

Scilab code Exa 6.13 Hall Effect

```
//chapter6,Example6_13,pg 125

e=1.6*10^-19

n=7*10^21

ue=0.39

V=10^-3

A=10^-6

L=10*10^-3

I=(n*e*ue*V*A)/L

Rhe=-(1/(n*e))

Bz=0.2

d=10^-3

Vhe=(Rhe*I*Bz)/d

```

```
printf("current through bar I=%.7f A\n",I)
printf("\nhall coeff. Rhe=%.6f m3/c\n",Rhe)
printf("\nhall voltage Vhe=%.8f volt\n",Vhe)
```

Scilab code Exa 6.14 `find forward bias current flow`

```
//chapter6,Example6_14,pg 136
J2=0.2*10^-6
e=1.6*10^-19
V=0.1
K=1.38*10^-23
T=300
J=J2*(e^((e*V)/(K*T)))//as e^((e*v)/KT)>>1
printf("forward bias current flow\n")
disp(J)
```

Scilab code Exa 6.15 `find static and dynamic resistance`

```
//chapter6,Example6_15,pg 148
V1=1.4
I1=60*10^-3
```

```
V2=1.5

I2=85*10^-3

Rs1=V1/I1

Rs2=V2/I2

dV=V2-V1

dI=I2-I1

Rd=dV/dI

printf("static resistance\n")

printf("Rs1=%.2f ohm\n",Rs1)

printf("Rs2=%.2f ohm\n",Rs2)

printf("dynamic resistance\n")

printf("Rd=%.2f ohm",Rd)
```

Scilab code Exa 6.16 `find alpha and beta`

```
//chapter6,Example6_16,pg 148

Ie=1*10^-3

Ib=0.02*10^-3

Ic=Ie-Ib

```

```
B=Ic/Ib

alpha=Ic/Ie

printf("alpha=%.2f \n",alpha)

printf("B=%.2f \n",B)
```

Scilab code Exa 6.17 find leakage current Iceo

```
//chapter6,Example6_17,pg 148

alpha=0.99

Icbo=0.5*10^-6

B=alpha/(1-alpha)

Iceo=(1/(1-alpha))*Icbo

printf("B=%.f \n",B)

printf("Iceo=%.8f A",Iceo)
```

Scilab code Exa 6.18 find alpha and beta

```
//chapter6,Example6_18,pg 148

delIc=2.5*10^-3

delIb=40*10^-6

B=delIc/delIb
```

```
alpha=B/(1+B)

printf("alpha=%.5f\n",alpha)

printf("B=%.2f",B)
```

Scilab code Exa 6.19 `find current gain`

```
//chapter6,Example6_19,pg 148

Ie=1*10^-3

Ib=0.04*10^-3

Ic=Ie-Ib

alpha=Ic/Ie

printf("current gain\n")

printf("alpha=%.2f",alpha)
```

Scilab code Exa 6.20 `find base current`

```
//chapter6,Example6_20,pg 149

V=1.5

R=10^3

Ic=V/R

```

```
alpha=0.96

Ie=Ic/alpha

Ib=Ie-Ic

printf("base current\n")

printf("Ib=%.6f A",Ib)
```

Chapter 8

Interference Diffraction And Polarisation

Scilab code Exa 8.1 distance of fringe from wedge

```
//chapter8,Example8_1,pg 180

alpha=0.01

n=10

lam=6000*10^-8

u=1.5

//for dark fringe 2*u*t*cos(alpha)=n*lam

//t=xtan(alpha)

//2*u*x*sin(alpha)=2*u*x*alpha=n*lam ->alpha is
    small, sin(alpha)=alpha

x=(n*lam)/(2*u*alpha)

```

```
printf("distance of 10th fringe from edge of wedge\n
   ")

printf("x=%.2f cm",x)
```

Scilab code Exa 8.2 light reflected in visible spectrum

```
//chapter8,Example8_2,pg 181

//for constructive interference of reflected light

//2*u*t*cos(r)=(2*n+1)(lam/2), where n=0,1,2,3

//for normal incidence

//r=0, cos(r)=1

t=5*10^-5

u=1.33

//for n=0 lam=lam1

lam1=4*u*t

//for n=1 lam=lam2

lam2=4*u*t*(1/3)

//for n=2 lam=lam3

lam3=4*u*t*(1/5)

//for n=3 lam=lam4

```

```
lam4=4*u*t*(1/7)

printf("wavelength that is strongly reflected in
   visible spectrum\n")

disp(lam3)
```

Scilab code Exa 8.3 radius of 50th dark ring

```
//chapter8,Example8_3,pg 181

n=10

D10=0.5

lam=5000*10^-8

R=(D10^2)/(4*n*lam)

D50=sqrt(4*50*R*lam)

r50=D50/2

printf("radius of 50th dark ring\n")

printf("r50=%.2f cm",r50)
```

Scilab code Exa 8.4 thickness of film

```
//chapter8,Example8_4,pg 182

i=45*(%pi/180)

```

```
u=1.33

r=asin(sin(i)/u)

r=r*(180/%pi)

//for bright fringe 2*u*t*cos(r)=(2*n+1)(lam/2)

//for minimum thickness n=0

lam=5000*10^-8

t=lam/(4*u*cos(r))

printf("min. thickness of film\n")

disp(t)
```

Scilab code Exa 8.5 find RI of oil

```
//chapter8,Example8_5,pg 182

//since both reflections occur at surface of denser
    medium

//condition for brightness for min thickness, n=1

//for normal incidence r=0, cos(r)=1

lam=5500*10^-8

V=0.2

A=100*100//converting into cm2

```

```
t=V/A

u=lam/(2*t)

printf("RI of oil\n")

printf("u=%.2f",u)
```

Scilab code Exa 8.6 change in film thickness

```
//chapter8,Example8_6,pg 183

lam=6300*10^-10

u=1.5

//condition for dark 2*u*t=n*lam

//condition for bright 2*u*t=(2*n-1)(lam/2)

//when t=0 n=0 order dark band will come and at edge
    10th bright band will come

n=10

t=(((2*n)-1)*(lam))/(4*u)

printf("thickness of air film\n")

printf("t=%.12f cm",t)
```

Scilab code Exa 8.7 thickness of layer

```
//chapter8,Example8_7,pg 183

ug=1.5

uo=1.3

//here reflection occurs both time at surface of
    denser medium

//condition for distructive interference in
    reflected side

//2*u*t*cos(r)=(2*n-1)(lam1/2), for nth min.

r=0

//for nth min.

//2*u*t=(2*n+1)(lam1/2), n=0,1,2,3

//for (n+1)th min.

////2*u*t=(2*(n+1)+1)(lam2/2), n=0,1,2,3

lam1=7000*10^-10

lam2=5000*10^-10

//from eq. of nth and (n+1)th min.

t=(2/(4*uo))*((lam1*lam2)/(lam1-lam2))

printf("thickness of layer\n")

printf("t=%.12f m",t)
```

Scilab code Exa 8.8 calculate RI of liquid

```
//chapter8,Example8_8,pg 184

Dn=1.40

D=1.27

//when u=1

//(Dn^2)=4*n*lam*R=(1.40^2)

//when u=u1

//(D^2)=(4*n*lam*R)/u1=(1.27^2)

//from above eqn's

u1=((Dn^2)/(D^2))

printf("RI of liquid\n")

printf("u=%.2f",u1)
```

Scilab code Exa 8.9 calculate wavelength of light

```
//chapter8,Example8_9,pg 184

alpha=((%pi*10)/(60*60*180))//converting into radian

B=0.5//fringe width

```

```
u=1.4

lam=2*B*alpha*u

printf("wavelength of light used\n")

printf("lam=%.12f m",lam)
```

Scilab code Exa 8.10 calculate change in thickness

```
//chapter8,Example8_10,pg 185

//condition for dark fringe is 2*t=n*lam

//refer to fig.(e) pg 185

//but B=(lam/(2*alpha*u))

//delt=alpha*x

lam=6000*10^-8

u=1.5

delt=(10*lam)/(2*u)//alpha=lam/(2*B*u), B=x/10

printf("difference t2-t1 from fig.\n")

printf("delt=%.4f cm",delt)
```

Scilab code Exa 8.11 calculate min thickness of glass plate

```
//chapter8,Example8_11,pg 185
```

```
//condition for dark is 2*u*t*cos(r)=n*lam

lam=5890*10^-8

u=1.5

r=60*(%pi/180)

//for n=1

t=(lam)/(2*u*cos(r))

printf("smallest thickness of glass plate\n")

printf("t=%.8f cm",t)
```

Scilab code Exa 8.12 position of brightest and darkest spot

```
//chapter8,Example8_12,pg 193

//for brightest spot R1=sqrt(b*lam)

R1=0.05

lam=5*10^-5

bb=(R1^2)/lam//brightest spot

//for darkest spot

bd=(R1^2)/(2*lam)//darkest spot

printf("position of brightest spot\n")

```

```
printf("b=%.2f cm",bb)

printf("\nposition of darkest spot\n")

printf("b=%.2f cm",bd)
```

Scilab code Exa 8.13 zone plate for point source

```
//chapter8,Example8_13,pg 193

lam=6000*10^-10

b1=30//for m=1

b2=6//for m=2

//(1/b)-(1/a)=(n*lam)/(R1^2), b=b1,b2

//from b1,b2 equations

a=((5*b2)-(3*b1))/2

R1=sqrt(lam/((1/b1)-(1/a)))

F1=(R1^2)/lam

printf("distance of source from zone plate\n")

printf("a=%.2f cm",a)

printf("\nradius of 1st zone plate\n")

printf("R1=%.4f cm",R1)

printf("\nprincipal focal length\n")
```

```
printf("F1=%.2f cm",F1)
```

Scilab code Exa 8.14 wavelength of spectral line

```
//chapter8,Example8_14,pg 209

grat=1/1250//transmission grating

n=2

theta=30*(%pi/180)//deviation angle

//(a+b)sin(theta)=n*lam

//grat=(a+b)

lam=(grat*sin(theta))/n//wavelength of spectral line

printf("wavelength of spectral line\n")

printf("lam=%.6f cm",lam)
```

Scilab code Exa 8.15 max orders visible

```
//chapter8,Example8_15,pg 209

lam=5893*10^-8

grat=2.54/2540//converting into cm

//(a+b)=grat

```

```
//(a+b)sin(theta)=n*lam

//n=nmax, if sin(theta)=1

nmax=(grat/lam)

printf("maximum order\n")

printf("nmax=%.2f ",nmax)

printf("so maximum order=16\n")
```

Scilab code Exa 8.16 linear separation of Na lines

```
//chapter8,Example8_16,pg 209

n=2

grat=1/5000//transmission grating

lam=5893*10^-8

dtheta=(2.5*3.14)/(180*60)//change in angular
    displacement(in radian)

//(a+b)=grat

//dlam=((a+b)cos(theta)/n)dtheta

theta=acos(sqrt(1-(((n*lam)/grat)^2)))
dlam=(dtheta*grat*cos(theta))/n//difference in
    wavelength

f=30//focal length

```

```
dl=f*dtheta//linear separation

printf("difference between two yellow lines (in cm)\n")

disp(dlam)

printf("\nlinear separation\n")

printf("dl=%.4f cm",dl)
```

Scilab code Exa 8.17 linear separation of spectra lines

```
//chapter8,Example8_17,pg 210

grat=1/6000

f=30

n=2

lam1=5770*10^-8

lam2=5460*10^-8

dlam=lam1-lam2

lam=lam2

theta=acos(sqrt(1-(((n*lam)/grat)^2)))
dl=((n*f)/(grat*cos(theta)))*dlam

printf("linear separation of two spectral lines\n")

printf("dl=%.4f cm",dl)
```

Scilab code Exa 8.18 calculate lines per cm in grating

```
//chapter8,Example8_18,pg 210

//nth order of lam1 is superimposed on (n+1)th order
    of lam2 for theta=30

//(a+b)sin(30)=n*5400*10^-8=(n+1)*4050*10^-8

lam1=5400*10^-8

lam2=4050*10^-8

n=(lam2/(lam1-lam2))

theta=30*(%pi/180)

N=sin(theta)/(n*lam1)

printf("lines/cm in grating\n")

printf("N=%.2f lines/cm",N)
```

Chapter 9

X Rays

Scilab code Exa 9.1 highest order of reflection

```
//chapter9 ,Example9_1 ,pg 237

d=4.255*10^-10

lam=1.549*10^-10//wavelength of K-copper line

n=1//theta is smallest when n=1

theta=asin(lam/(2*d))//glancing angle

theta=theta*(180/%pi)

//max value of sin(theta)=1

//for highest order

nmax=((2*d)/lam)//highest bragg's order

printf("smallest glancing angle\n")

printf("theta=%.2f deg.",theta)
```

```
printf("\nmaximum order of reflection\n")

printf("nmax=%.2f",nmax)

printf("\nsince fraction is meaningless for order
   nmax=5")
```

Scilab code Exa 9.2 find plancks constant

```
//chapter9,Example9_2,pg 237

V=60*10^3

c=3*10^8

e=1.6*10^-19

lam=0.194*10^-10//min. wavelength of x-rays

h=(lam*e*V)/c

printf("plancks constant\n")

disp(h)
```

Scilab code Exa 9.3 find wavelength and maximum order of reflection

```
//chapter9,Example9_3,pg 238

//for 110 plane

a=3*10^-10//lattice parameter
```

```
d=(a/sqrt(2))//d110=(a/sqrt((1^2)+(1^2)+0))

theta=12.5*(%pi/180)//glancing angle

n=1

lam=2*d*sin(theta)//wavelength of x-ray

nmax=((2*d)/lam)//highest order

printf("wavelength of x-ray beam\n")

disp(lam)

printf("\nhighest braggs order\n")

printf("nmax=%.2f",nmax)

printf("\nfraction is meaningless so nmax=4")
```

Scilab code Exa 9.4 `find plancks constant`

```
//chapter9,Example9_4,pg 238

d=2.81*10^-10

theta=14*(%pi/180)//glancing angle

lam=2*d*sin(theta)//min. wavelength

e=1.6*10^-19

V=9100

```

```
c=3*10^8

h=(lam*e*V)/c

printf("plancks constant\n")

disp(h)
```

Scilab code Exa 9.5 find wavelength of line A

```
//chapter9,Example9_5,pg 238

//for line A-> 2*d*sin(thetaA)=lamA(n=1)

thetaA=30*(%pi/180)//glancing angle for line A

//for line B-> 2*d*sin(thetaB)=3*lamB(n=3)

thetaB=60*(%pi/180)

lamB=0.97*10^-10

d=(3*lamB)/(2*sin(thetaB))

lamA=2*d*sin(thetaA)//wavelength of line A

printf("wavelength of line A\n")

disp(lamA)
```

Scilab code Exa 9.6 find wavelength of x rays

```
//chapter9,Example9_6,pg 239
```

```
a=3.615*10^-10

d111=a/sqrt(1+1+1)//for 111 plane

theta=21.7*(%pi/180)//converting into radian

lam=2*d111*sin(theta)

printf("wavelength of X-rays\n")

disp(lam)
```

Scilab code Exa 9.7 find min wavelength and glancing angle

```
//chapter9,Example9_7,pg 239

V=50*10^3

lam=(12400/V)*10^-10

n=4//FCC crystal

m=74.6

N=6.022*10^26

rho=1.99*10^3

a=(((n*m)/(N*rho))^(1/3))

//for kcl ionic crystal

d=a/2

```

```
theta=asin(lam/(2*d))

theta=theta*(180/%pi)

printf("min. wavelength of spectrum from tube\n")

disp(lam)

printf("glancing angle for that wavelength\n")

printf("theta=%.2f deg.",theta)
```

Scilab code Exa 9.8 identify type of crystal

```
//chapter9,Example9_8,pg 239

//from bragg's law

//2*d*sin(theta)=n*lam

n=1

theta1=5.4*(%pi/180)

theta2=7.6*(%pi/180)

theta3=9.4*(%pi/180)

lam = 2

d100=lam/2*sin(theta1)

d110=lam/2*sin(theta2)

d111=lam/2*sin(theta3)
```

```

printf("ratio of interplannar spacing \n(1/d100):(1/d110):(1/d111)=")

printf("%.2f:",sin(theta1));printf("%.2f:",sin(theta2));printf("%.2f",sin(theta3));

printf("\nas ratio (1/d100):(1/d110):(1/d111)=1:sqrt(2):sqrt(3) this relation is valid for simple cubic crystal therefore, this is a SCC crystal")
```

Scilab code Exa 9.9 `find interplannar spacing`

```
//chapter9,Example9_9,pg 240

lam=0.58*10^-10

theta1=6.5*(%pi/180)

theta2=9.15*(%pi/180)

theta3=13*(%pi/180)

//from bragg's law

d1=lam/(2*sin(theta1))*10^10

d2=lam/(2*sin(theta2))*10^10

d3=lam/(2*sin(theta3))*10^10

printf("interplannar spacing of crystal\n")

printf("%.2f:",d1);printf("%.2f:",d2);printf("%.2f",d3);
```

Chapter 10

Motion Of Charged Particle In Electric And Magnetic Field

Scilab code Exa 10.1 find KE of particle

```
//chapter10,Example10_1,pg 270

L=1.33*10^-22

B=0.025

m=6.68*10^-27

q=3.2*10^-19

w=(B*q)/m

E=0.5*L*w//E=0.5I(w^2),Iw=L

E=E/(1.6*10^-19)//converting into ev

printf("KE of particle\n")

printf("E=%.2f ev",E)
```

Scilab code Exa 10.2 frequency of oscillation and maximum energy of particle

```
//chapter10,Example10_2,pg 271

R=0.35

n=1.38*10^7

m=1.67*10^-27

q=1.6*10^-19

B=(2*%pi*n*m)/q

E=((B^2)*(q^2)*(R^2))/(2*m)

E=E/q

printf("magnetic field induction\n")

printf("B=%.2f wb/m2",B)

printf("\nmaximum energy of proton\n")

printf("E=%.2f ev",E)
```

Scilab code Exa 10.3 radius of electron trajectory and angular momentum

```
//chapter10,Example10_3,pg 271

m=9.1*10^-31
```

```
e=1.6*10^-19

//due to potential difference V, electron is accelerated

//eV=0.5*m*(v^2)

//due to transverse magnetic field B electron moves in circular path of radius R

//(m*(v^2))/R=BeV

B=1.19*10^-3

V=1000

v=sqrt((2*e*V)/m)

R=(m*v)/(B*e)

L=m*v*R

printf("radius of electron trajectory\n")

printf("R=%.2f m",R)

printf("\nangular momentum of electron\n")

disp(L)
```

Scilab code Exa 10.4 vertical displacement and magnetic field of electron

```
//chapter10,Example10_4,pg 272
e = 1.6*10^-19;
```

```
m=9.1*10^-31;
vx=1.7*10^7

Ey=3.4*10^4

x=3*10^-2

t=x/vx

//y=0.5*ay*(t^2)

ay=(e*Ey)/m

y=0.5*ay*(t^2)

Bz=Ey/vx

printf("verical displacement of electron \n")

printf("y=%.2f m",y)

printf("\nmagnitude of magnetic field\n")

printf("B=%.4f wb/m2",Bz)

printf("\ndirection of field is upward as Ey is
   downward")
```

Scilab code Exa 10.5 resonance frequency and maximum energy of proton

```
//chapter10,Example10_5,pg 272

m=1.67*10^-27

q=1.6*10^-19
```

```
B=0.5
n=((B*q)/(2*%pi*m))
R=1
E=((B^2)*(q^2)*(R^2))/(2*m)
E=E/(1.6*10^-19)
printf("frequency of oscillation voltage\n")
printf("n=%.2f Hz",n)
printf("\nmaximum energy of proton\n")
printf("E=%.2f ev",E)
```

Scilab code Exa 10.6 `calculate force periodic time and resonance frequency`

```
//chapter10,Example10_6,pg 273
q=3.2*10^-19
m=6.68*10^-27
B=1.5
v=7.263*10^6
F=B*q*v
printf("force on particle\n")
```

```
disp(F)
T=(2*%pi*m)/(B*q)
n=1/T
printf("\nperiodic time\n")
disp(T)
printf("\nresonance frequency\n")
printf("n=%.2f Hz",n)
```

Scilab code Exa 10.7 calculate flux density and radius of cyclotron for proton and

```
//chapter10,Example10_7,pg 273
n=1.2*10^7
mp=1.67*10^-27
qp=1.6*10^-19
Bp=(2*%pi*mp*n)/qp
R=0.5
Ep=((Bp^2)*(qp^2)*(R^2))/(2*mp)
Ep=Ep/qp
malp=6.68*10^-27
qalp=2*1.6*10^-19
```

```
Balp=(2*%pi*malp*n)/qalp

Ealp=((Balp^2)*(qalp^2)*(R^2))/(2*malp)

Ealp=Ealp/qp

printf("flux density for proton\n")

printf("Bp=%.2f Wb/m2",Bp)

printf("\nflux density for alpha particle\n")

printf("Balp=%.2f Wb/m2",Balp)

printf("\nenergy of proton\n")

printf("Ep=%.2f ev",Ep)

printf("\nenergy of alpha particle\n")

printf("Ealp=%.2f ev",Ealp)
```

Scilab code Exa 10.8 linear separation of electron beam

```
//chapter10,Example10_8,pg 274

e=1.6*10^-19

me=9.1*10^-31//mass of electron

q=3.2*10^-19

malp=6.68*10^-27//mass of alpha particle

```

```
B=0.05

V=20*10^3

//v=sqrt((2*q*V)/m)

//R=(1/B)*sqrt((2*m*V)/q)

Re=(1/B)*sqrt((2*me*V)/e)

Ralp=(1/B)*sqrt((2*malp*V)/q)

S=2*Ralp-2*Re//linear separation between two
    particles on common boundary wall

printf("linear separation between two particles on
    common boundary wall\n")

printf("S=%.2f m",S)
```

Scilab code Exa 10.9 `find potential difference`

```
//chapter10,Example10_9,pg 274

V1=200

//electrostatic focusing condition

//(sini/sinr)=(v2/v1)=sqrt(V2/V1)

//0.5mv2=eV

i=60*(%pi/180)//converting into radian

r=45*(%pi/180)//converting into radian
```

```
V2=200*((sin(i)/sin(r))^2)

pd=V2-V1//potential difference

printf("potential difference between two region\n")

printf("\npd=%.2f Volts",pd)
```

Scilab code Exa 10.10 charge on drop

```
//chapter10,Example10_10,pg 275

//F=mg=qE

E=250

R=10^-8

rho=10^3//density

m=(4/3)*%pi*(R^3)*rho//m=volume*density

W=m*9.8//weight of drop(mg)

q=W/E

printf("charge on water drop\n")

disp(q)
```

Scilab code Exa 10.11 bainbridge mass spectograph

```
//chapter10,Example10_11,pg 275

e=1.6*10^-19

v=5*10^5

B=0.3

N=6.025*10^26

M72=72/N

R72=(M72*v)/(B*e)

M74=74

R74=(R72/72)*M74

S=2*(R74-R72)//linear separation of two line

printf("linear separation of two line\n")

printf("S=%.2f m",S)
```

Scilab code Exa 10.12 `calculate flux density`

```
//chapter10,Example10_12,pg 276

l=5*10^-2

d=0.3//distance of screen from end of mag. field

D=d+(l/2)

y=0.01
```

```
m=9.1*10^-31

e=1.6*10^-19

Va=1000

B=(y/(D*l))*sqrt((2*m*Va)/e)

printf("flux density\n")

printf("B=%.8f Wb/m2",B)
```

Scilab code Exa 10.13 electron in transverse electric field

```
//chapter10,Example10_13,pg 276

e=1.6*10^-19

Va=150

m=9.1*10^-31

vx=sqrt((2*e*Va)/m)

V=20

d=10^-2

ay=(e/m)*(V/d)

l=10*10^-2

vy=ay*(l/vx)

```

```
theta=atan(vy/vx)

theta=theta*(180/%pi)//converting into degree

theta=theta*(%pi/180)//converting into radian

Y=d*tan(theta)

S=(Y/V)

printf("velocity of electron reaching field vx=%.2f
   m/sec\n",vx)

printf("\nacceleration due to electric field ay=%.2f
    m/sec2\n",ay)

printf("\nfinal velocity attained by deflecting
   field vy=%.2f m/sec\n",vy)

printf("\nangle of deflection theta=%.2f deg.\n",
   theta)

printf("\ndeflection on screen Y=%.2f m\n",Y)

printf("\ndeflection senstivity S=%.2f m/volt\n",S)
```

Chapter 11

Quantum Physics And Schrodinger Wave Equation

Scilab code Exa 11.1 `uncertainity in velocity`

```
//chapter11,Example11_1,pg 298

me=9.1*10^-31//masss of electron

h=6.62*10^-34//planck's const.

delx=10^-8//uncertainity in position

delp=(h/(2*%pi*delx))//uncertainity principle

delv=(delp/me)//uncertainity in velocity

printf("uncertainity in velocity\n")

printf("delv=%.2f m/sec",delv)
```

Scilab code Exa 11.2 find KE and velocity of proton

```
//chapter11,Example11_2,pg 298

lam=0.2865*10^-10//wavelength

mp=1.67*10^-27//mass of proton

h=6.625*10^-34

v=(h/(mp*lam))//debroglie's equation

KE=0.5*mp*(v^2)//kinetic energy of proton(J)

KE=KE/(1.6*10^-19)//converting into ev

printf("kinetic energy of proton\n")

printf("KE=%.2f ev",KE)
```

Scilab code Exa 11.3 momentum and energy of electron and photon

```
//chapter11,Example11_3,pg 299

KEnu=0.025*1.6*10^-19//kinetic energy of neutron

mn=1.676*10^-27//mass of neutron

v=sqrt((2*KEnu)/mn)

h=6.626*10^-34

lamn=h/(mn*v)//debroglie wavelength of neutron

printf("wavelength of beam of neutron\n")
```

```
printf("lamn=%.12f m",lamn)

p=(h/lamn)

printf("\nmomentum of electron and photon\n")

printf("p=%.26f kgm/sec",p)

me=9.1*10^-31//mass of electron

ve=(p/me)//velocity of electron

Ee=0.5*p*ve//energy of electron

Ee=Ee/(1.6*10^-19)//convering into ev

printf("\nenergy of electron\n")

printf("Ee=%.2f ev",Ee)

Ep=(h*3*10^8)/lamn//energy of photon

Ep=Ep/(1.6*10^-19)

printf("\nenergy of photon\n")

printf("Ep=%.2f ev",Ep)
```

Scilab code Exa 11.4 find mass of particle

```
//chapter11,Example11_4,pg 300

e=1.6*10^-19

```

```
V=200

lam=0.0202*10^-10//debroglie wavelength

h=6.625*10^-34

//eV=0.5*m*(v^2)

//mv=sqrt(2*m*eV)

m=((h^2)/(2*(lam^2)*e*V))//mass of particle

printf("mass of particle\n")

disp(m)
```

Scilab code Exa 11.5 calculate debroglie wavelength of neutron

```
//chapter11,Example11_5,pg 300

mn=1.676*10^-27//mass of neutron

h=6.625*10^-34

En=1.6*10^-19//energy of neutron

v=sqrt((2*En)/mn)

lam=(h/(mn*v))//de-broglie wavelength

printf("de-broglie wavelength\n")

disp(lam)
```

Scilab code Exa 11.6 existence of electron within nucleus

```
//chapter11,Example11_6,pg 300

//acc. to uncertainity principle

//delx*delp >= (h/2*%pi)

rad=10^-14

delx=2*rad

h=6.625*10^-34

delp=(h/(2*%pi*delx))

//from einstein's relavistic relation

//E=mc2=KE+rest mass energy=0.5mv2+moc2

//when velocity of particle is very high

//m=(mo/sqrt(1-((v/c)^2)))

//m-mass of particle with velocity v

//mo-rest mass of particle

//c-velocity of particle

p=delp//assume

c=3*10^8

```

```
mo=9.1*10^-31

E=sqrt(((p*c)^2)+((mo*(c^2))^2))

E=E/(1.6*10^-19)

printf("E=%.2f ev",E)

printf("\nthis value is much higher than
   experimentally obtained values of energy of
   electron\n")

printf("of a radioactive nuclei i.e 4 Mev this
   proves that electron cannot reside within nucleus
   ")
```

Scilab code Exa 11.7 calculate debroglie wavelength

```
//chapter11,Example11_7,pg 302

m1=60*10^-9

v1=80

p1=m1*v1

h=6.625*10^-34

lam1=h/p1//de-broglie wavelength case-1

m2=8*10^-27

v2=1.3

p2=m2*v2
```

```
lam2=h/p2//de-broglie wavelength case-2

printf("de-broglie wavelength for case-1\n")

disp(lam1)

printf("\nde-broglie wavelength for case-2\n")

disp(lam2)

printf("\nfrom case-1 it is clear that for normal
   particles de-broglie wavelength is not visible it
    is very small")
```

Scilab code Exa 11.8 calculate KE of electron

```
//chapter11,Example11_8,pg 302

h=6.634*10^-34

c=3*10^8

e=1.6*10^-19

m=9.1*10^-31

Ep=100*10^3*e//energy of photon

lamp=((h*c)/Ep)//wavelength of photon

lame=lamp//wavelength of electron

v=h/(m*lame)

```

```
KEe=0.5*m*(v^2)//kinetic energy of electron

KEe=KEe/(1.6*10^-19)

printf("kinetic energy of electron\n")

printf("KEe=%.2f ev",KEe)
```

Chapter 12

Laser Holography And Fibre Optics

Scilab code Exa 12.1 normalised frequency and guided modes

```
//chapter12 ,Example12_1 ,pg 357

n1=1.53//refractive index

n2=1.5

lam=1*10^-6//wavelength

a=50*10^-6

NA=sqrt((n1^2)-(n2^2))

V=((2*%pi*a)*NA)/lam

printf("normalised frequency\n")

printf("V=%.2f ",V)

M=(V^2)/2
```

```
printf("\ntotal no. of guided mode\n")

printf("M=%.2f",M)
```

Scilab code Exa 12.2 `find core radius`

```
//chapter12,Example12_2,pg 357

lam=1*10^-6//wavelength

n1=1.53

n2=1.5

NA=sqrt((n1^2)-(n2^2))

a=(2.405*lam)/(2*%pi*NA)

printf("core radius\n")

printf("a=%.8f m",a)
```

Scilab code Exa 12.3 `calculate relative change in core cladding RI`

```
//chapter12,Example12_3,pg 357

NA=0.5

n1=1.54

n2=sqrt((n1^2)-(NA^2))

```

```
printf("refractive index of cladding\n")

printf("n2=%.2f ",n2)

n=(n1-n2)/n1//relative change in refractive index of
    core

printf("\nrelative change refractive index of core\n
    ")

printf("n=%.2f ",n)
```

Scilab code Exa 12.4 `find cladding RI and acceptance angle`

```
//chapter12,Example12_4,pg 358

NA=0.5

n1=1.48

n2=sqrt((n1^2)-(NA^2))

printf("refractive index of cladding\n")

printf("n2=%.2f ",n2)

alpha=asin(NA)

alpha=alpha*(180/%pi)

printf("\nacceptance angle\n")

printf("alpha=%.2f deg",alpha)
```

Chapter 13

Radioactivity And Nuclear Reactions

Scilab code Exa 13.1 energy of incident particle

```
//chapter13,Example13_1,pg 391

//xMy -> x-mass no., M-element, y-atomic no.

M7Li3=7.018232//mass of 7li3 (amu)

Malpha=4.003874//mass of alpha particle (amu)

Mpr=1.008145//mass of proton (amu)

//reaction:- 7li3 + 1H1-> 4He2 + 4He2

delM=M7Li3+Mpr-2*Malpha//mass defect

Q=delM*931//1 amu= 931 Mev

Ey=9.15//K.E energy of product nucleus

Ex=2*Ey-Q//K.E of incident particle
```

```
printf("kinetic energy of incident proton\n")

printf("Ex=%.2f Mev",Ex)
```

Scilab code Exa 13.2 power of explosion

```
//chapter13,Example13_2,pg 391

M235U=235//at.mass of 235U

m=10^-3

N=6.023*10^23

Eperfi=200*10^6//energy per fission

E=Eperfi*1.6*10^-19//energy per fission (in joules)

T=10^-6

A=M235U

P=((m*N)/A)*(E/T)//power output

printf("power of explosion\n")

printf("P=%.2f watt",P)
```

Scilab code Exa 13.4 mass of uranium consumed

```
//chapter13,Example13_4,pg 392

```

```
n=0.4//efficiency

N=6.023*10^23

Eperfi=200*10^6//energy per fission

E=Eperfi*1.6*10^-19

P=100*10^6

A=235

T=24*60*60

m=(P*A*T)/(n*N*E)

printf("mass of 235U consumed/day\n")

printf("m=%.2f gm",m)
```

Scilab code Exa 13.5 energy liberated per reaction

```
//chapter13,Example13_5,pg 392

M2H1=2.01474

M3H1=3.01700

M1n0=1.008986

M4He2=4.003880

//thermonuclear reaction in hydrogen bomb explosion

//2H1 + 3H1 -> 4He2 + 1n0
```

```
Mreac=M2H1+M3H1//mass of reactants

Mprod=M4He2+M1n0//mass of products

Q=Mreac-Mprod

Q=Q*931//converting in Mev

printf("energy/reaction\n")

printf("Q=%.2f Mev",Q)
```

Scilab code Exa 13.6 calculate binding energy

```
//chapter13,Example13_6,pg 393

M7Li3=7.01818

M1H1=1.0081

M1n0=1.009

BEpernu=(1/7)*((3*M1H1)+(4*M1n0)-M7Li3)//binding
    energy per nucleon

BEpernu=BEpernu*931//converting in Mev

printf("binding energy per nucleon\n")

printf("BE=%.2f Mev",BEpernu)
```

Scilab code Exa 13.7 calculate power output

```
//chapter13,Example13_7,pg 394

m=10*10^3

N=6.023*10^23

Eperfi=200*10^6//energy per fission

E=Eperfi*1.6*10^-19//energy in joules

A=235

T=24*60*60

P=((m*N)/A)*(E/T)

printf("power output\n")

printf("P=%.2f watt",P)
```