Scilab Textbook Companion for Material Science In Engineering by Dr. K. M. Gupta[1]

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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 4

2 REVIEW OF ATOMIC CONCEPTS ATOMIC MODELS AND PERIODIC TABLE 5

3 CHEMICAL BONDING 10

4 CRYSTALLOGRAPHY 12

5 MILLER INDICES AND X RAY CRYSTALLOGRAPH TECHNIQUES 15

6 IMPERFECTIONS DEFECTS AND DISLOCATIONS IN SOLIDS 21

7 MECHANICAL PROPERTIES 24

8 MECHANICAL TESTING 26

9 MICROSTRUCTURAL EXAMINATION AND NON DESTRUCTIVE TESTING 31

10 PHASE DIAGRAM AND EQUILIBRIUM DIAGRAM 33

12 HEAT TREATMENT 37

14 MAGNETIC PROPERTIES AND MATERIALS 39

15 ELECTRIC PROPERTIES 44

16 SUPERCONDUCTIVITY AND SUPERCONDUCTORS 51

17 CERAMICS AND PLASTICS 56

19 COMPOSITE MATERIALS 58

20 PERFORMANCE OF MATERIALS IN SERVICE 62

21 DIFFUSION IN SOLIDS 66

List of Scilab Codes

Exa 2.1	Find average atomic weight of Hydrogen	5
Exa 2.2	Find distance	6
Exa 2.3	Find number of particles scattered at 75 and 135 degree	6
Exa 2.4	Find radius of first orbit of electron in Hydrogen atom	7
Exa 2.5	Find Ionisation Energy	8
Exa 2.6	Find dimensions of elliptical locus	8
Exa 2.7	Find Minimum Uncertainity in Position	9
Exa 3.4	Find Energy of third and fifth orbit	10
Exa 3.5	Find dipole moment and percentage ionic character	10
Exa 4.3	Find Lattice constant and atomic packing fraction of NaCl having FCC structure	12
Exa 4.4	Find density of Copper	13
Exa 4.5	Find distance between two adjacent atoms	13
Exa 4.6	Find atomic radius	14
Exa 5.1	Find MILLER INDICES OF THE PLANE	15
Exa 5.3	Find MILLER INDICES OF THE PLANE	16
Exa 5.5	Find interplanar Spacing	16
Exa 5.6	Find Linear Density per unit length	17
Exa 5.7	Find Planar Density	18
Exa 5.8	Find Glancing angle and Interplanar spacing of the crystal	19
Exa 5.9	Find Glancing angle and lattice parameter	19
Exa 5.10	Find Dimension of unit cell	20
Exa 6.1	Find No of Frenkel defect	21
Exa 6.2	Calculate Ratio of no of vacancies	22
Exa 6.4	Find Elastic Strain Energy	22
Exa 6.5	Calulate Total number of created vacancies	23
Exa 7.3	Find various Modulous of elasticity	24

Exa 7.5 Find stress . . . 25
Exa 8.1 Find Flexural Strength Shear Strength and Modulous of Rupture . . . 26
Exa 8.2 FIND BRINELL HARDNESS NUMBER . . . 27
Exa 8.3 Find Rupture Energy Modulous Of Rupture and Notch Imapct Strength . . . 27
Exa 8.4 Find Stress Ratio and range . . . 28
Exa 8.5 Calculate ENDURANCE STRESS FROM using various relations . . . 29
Exa 9.1 Find grain diameter . . . 31
Exa 9.2 Find Average and Boundary area . . . 31
Exa 10.1 Prove Two component system cannot have more than 4 phases in an equilibrium . . . 33
Exa 10.2 Calculate Total weight of lead and tin . . . 34
Exa 10.4 Find weight fractions . . . 34
Exa 10.5 Find Maximum weight of tin . . . 35
Exa 10.6 Find Weight fraction of errite and Cementite . . . 35
Exa 12.1 calculate percentage change in volume . . . 37
Exa 12.3 Estimate free energy change during recrystallization . . . 37
Exa 12.5 Find contribution of particles . . . 38
Exa 14.1 Find relative permeability and Intensity of magnetisation 39
Exa 14.2 Estimate Hysteresis energy loss per unit volume . . . 40
Exa 14.3 Find Power loss due to Hysteresis . . . 40
Exa 14.4 Find Loss at 40 Hz . . . 41
Exa 14.5 Find Magnetic strength . . . 41
Exa 14.6 Estimate Saturation Magnetisation . . . 42
Exa 14.9 Find Eddy current loss at 60 and 100 Hz . . . 42
Exa 14.13 Find Magnetic field strength and Flux density . . . 43
Exa 15.1 Find Electric field . . . 44
Exa 15.2 Find Drift Velocity . . . 44
Exa 15.3 Find Specific Resistance . . . 45
Exa 15.4 Find Resistivity . . . 45
Exa 15.5 Calculate Intrinsic Carrier density . . . 46
Exa 15.6 Estimate Drift Velocity and time taken by electrons . . . 47
Exa 15.7 Find Impurity concentration . . . 47
Exa 15.8 Calculate Conduction electron and hole density . . . 48
Exa 15.9 Calculate Hole concentration . . . 48
Exa 15.10 Find thickness of insulation . . . 49

Exa 15.16 Find Band gap energy 49
Exa 16.1 find susceptibilty and relative permeability of a superconductor 51
Exa 16.2 Determine critical field 52
Exa 16.3 Find critical current 52
Exa 16.4 Find electron and current density 53
Exa 16.9 determine critical current density 53
Exa 16.10 Determine transition temperature and critical field . . 54
Exa 17.1 Calculate molecular weight 56
Exa 17.2 Determine molecular weight of teflon 56
Exa 19.1 Find flexural rigidity of sandwich construction 58
Exa 19.2 Determine volume ratio of Al and B in aluminium boron composite 58
Exa 19.3 Calculate fraction of load carried by fibres 59
Exa 19.4 Find longitudinal strength longitudianl modulous transverse modulous Poisson ratio Shear modulous 60
Exa 20.1 Find fracture strength and ratio 62
Exa 20.2 Investigate an oxidation film will form over Nickel or not 63
Exa 20.3 Find how much loss will occur in 300 hours 63
Exa 20.4 Determine PBR ratio 64
Exa 20.5 Find quantity of magnesium needed 64
Exa 21.1 Find Concentration Gradient and diffusivity 66
Exa 21.2 Find Concentration Gradient and diffusivity and rate . 66
Exa 21.4 Calculate Activation Energy in Silver diffusion 67

Chapter 2

REVIEW OF ATOMIC CONCEPTS ATOMIC MODELS AND PERIODIC TABLE

Scilab code Exa 2.1 Find average atomic weight of Hydrogen

```
1  //Find average atomic weight of Hydrogen.
2  //Exa:1.1
3  close;
4  clc;
5  clear;
6  a1=1.0078;//atomic weight of H-1
7  a2=2.0143;//atomic weight of H-2
8  p1=99.985;//% of H-1
9  p2=.015;//% of H-2
10 a=((a1*p1)+(a2*p2))/100
11 disp(a,"Average atomic weight of Hydrogen = ");
```

Scilab code Exa 2.2 Find distance

```
1 //Ex:2.2
2 clc;
3 clear;
4 close;
5 z=79;//atomic no. of gold
6 e=7.68*1.6*10^-13;//ke in J
7 e_c=1.6*10^-19;//charge of electron in C
8 e_0=8.854*10^-12;//permittivity F/m
9 d=(2*e_c^2*z)/(4*3.14*e_0*e);//distance in m
10 disp(d,"distance (in m) = ");
```

Scilab code Exa 2.3 Find number of particles scattered at 75 and 135 degree

```
1 //Find number of particles scattered at 75 and 135
    degree
2 //Ex:2.3
3 clc;
4 clear;
5 close;
6 n=44;//no. of particles scattered per minute
7 a=90;//angle in degrees
8 x=sind(a/2);
9 c=n*x^4;
10 disp(c,"Proportionality constant = ");
11 b=75;//angle in degrees
```

```
12 y=sind(b/2);
13 n1=c/y^4;
14 disp(n1,"No. of particles scattered at 75 degree (in
       per minute) = ");
15 d=135;//angle in degrees
16 z=sind(d/2);
17 n2=c/z^4;
18 disp(n2,"No. of particles scattered at 135 degree (
      in per minute) = ");
```

Scilab code Exa 2.4 Find radius of first orbit of electron in Hydrogen atom

```
1 //Find radius of first orbit of electron in Hydrogen
      atom
2 //Ex:2.4
3 clc;
4 clear;
5 close;
6 n=1;//first orbit
7 e_0=8.85*10^-12;//permittivity in freee space
8 h=6.62*10^-34;//planck's constant
9 m=9.1*10^-31;//mass of an electron in kg
10 e=1.6*10^-19;//charge of an electron in C
11 z=1;
12 r=n^2*e_0*h^2/(3.14*m*e^2*z);//radius of first orbit
      in m
13 r1=r*10^10;//radius in Angstorm
14 disp(r1,"Radius of first orbit of electron in
      Hydrogen atom (in Angstorm) = ");
```

Scilab code Exa 2.5 Find Ionisation Energy

```
1 //Find Ionisation Energy
2 //Ex:2.5
3 clc;
4 clear;
5 close;
6 e_0=8.85*10^-12;//permittivity in freee space in sqC
    /N/sqm
7 h=6.62*10^-34;//planck's constant in Js
8 m=9.1*10^-31;//mass of an electron in kg
9 e=1.6*10^-19;//charge of an electron in C
10 z=1;//for hydrogen
11 n=1;
12 e=m*z^2*e^4/(8*e_0^2*h^2*n^2);//ionisation energy in
    J
13 disp(e,"Ionisation Energy (in J) = ");
14 e1=e/(1.602*10^-19);//in eV
15 disp(e1,"Ionisation Energy (in eV) = ");
```

Scilab code Exa 2.6 Find dimensions of elliptical locus

```
1 //Find dimensionsof elliptical locus
2 //Ex:2.6
3 clc;
4 clear;
5 close;
6 n=4;//fourth orbit
```

```
a=(0+1)/n;//for s suborbit
disp(a,"For s suborbit b/a = ");
b=(1+1)/n;//for p suborbit
disp(b,"For p suborbit b/a = ");
c=(2+1)/n;//for d suborbit
disp(c,"For d suborbit b/a = ");
d=(3+1)/n;//for f suborbit
disp(d,"For f suborbit b/a = ");
```

Scilab code Exa 2.7 Find Minimum Uncertainity in Position

```
//Find Minimum Uncertainity in Position
//Ex:2.7
clc;
clear;
close;
h=6.62*10^-34;//planck's constant in Js
p=10^-27;//uncertainity in momentum in kg m/s
x=h/(2*3.14*p);//uncertainity in position in m
disp(x,"Minimum Uncertainity in Position (in m) = ")
   ;
```

Chapter 3

CHEMICAL BONDING

Scilab code Exa 3.4 Find Energy of third and fifth orbit

```
1 //Find Energy of third and fifth orbit
2 //Ex:3.4
3 clc;
4 clear;
5 close;
6 e1=-13.6;//ionization potential of hydrogen in volts
7 n=3;//third orbit
8 e3=e1/(n^2);//Energy of third orbit in volts
9 disp(e3,"Energy of third orbit (in volts) = ");
10 m=5;//fifth orbit
11 e5=e1/(m^2);//Energy of fifth orbit in volts
12 disp(e5,"Energy of fifth orbit (in volts) = ");
```

Scilab code Exa 3.5 Find dipole moment and percentage ionic character

```
1 //Find Dipole moment and  Percentage ionic character
2 //Ex:3.5
```

```
clc;
clear;
close;
d=0.9178;//molecular distance in angstorm
d1=d*10^-10;//in m
e=1.602*10^-19;//in C
dm=e*d1;//dipole moment in fully ionic state in Cm
disp(dm,"Dipole moment of HF in fully ionic state (
   in Cm) = ");
dm_m=6.375*10^-30;//meaured dipole moment in Cm
p=(dm_m*100)/dm;//Percentage ionic character
disp(p,"Percentage ionic character");
```

Chapter 4

CRYSTALLOGRAPHY

Scilab code Exa 4.3 Find Lattice constant and atomic packing fraction of NaCl having FCC structure

```
1 //Find Lattice constant and atomic packing fraction
     of NaCl having FCC structure
2 //Ex:4.3
3 clc;
4 clear;
5 close;
6 r_na=0.98;//ionic radius of sodium in angstorm
7 r_cl=1.81;//ionic radius of chlorine in angstorm
8 n=4;//in fcc there are 4 Na and 4 Cl ions
9 a=((2*r_na)+(2*r_cl));//latice constant
10 disp(a,"Lattice constant = ");
11 apf=((n*(4/3)*3.14*r_na^3)+(n*(4/3)*3.14*r_cl^3))/a
     ^3;
12 disp(apf,"atomic packing fraction of NaCl having FCC
      structure = ");
```

Scilab code Exa 4.4 Find density of Copper

```
1 //Find density of Copper
2 //Ex:4.4
3 clc;
4 clear;
5 close;
6 r=1.278;//radius of copper in angstorm
7 //copper has FCC structure
8 a=4*r/sqrt(2);//in angstorm
9 disp(a,"a (in Angstorm) = ");
10 a1=a*10^-8;//in cm
11 aw=63.54;//atomic weight of copper
12 ne=4;//fcc
13 na=6.023*10^23;//Avagadro's no.
14 p=aw*ne/(na*a1^3);//in g/cm^3
15 p1=10^3*p;
16 disp(p1,"Density of Copper (in kg/cu m)");
```

Scilab code Exa 4.5 Find distance between two adjacent atoms

```
1 //Find Distance between two adjacent atoms
2 //Ex:4.5
3 clc;
4 clear;
5 close;
6 w_na=23;//atomic weight of Na
7 w_cl=35.5;//atomic weight of Cl
8 w=w_na+w_cl;//effective no.of atoms in FCC structure
9 n=4;//FCC
10 na=6.023*10^23;//Avagadrro's no.
11 w_4=w*n/na;//weight of 4 molecules in gm
12 p=2.18;//density in gm/cm^3
```

```
13 a=(w_4/p)^(1/3);//in cm
14 a1=a*10^8;//in angstorm
15 disp(a1,"unit cell dimension (in angstorm) = ");
16 d=a1/2;
17 disp(d,"Distance between two adjacent atoms (in
      Angstorm) = ");
```

Scilab code Exa 4.6 Find atomic radius

```
1 //Find atomic radius
2 //Ex:4.6
3 clc;
4 clear;
5 close;
6 n=2;//BCC
7 p=7.86;//density in gm/cm^3
8 aw=55.85;//atomic weight of iron
9 na=6.023*10^23;//Avagadrro's no.
10 a=((aw*n)/(na*p))^(1/3);//in cm
11 a1=a*10^8;//in angstorm
12 disp(a1,"unit cell dimension of iron (in angstorm) =
     ");
13 r=sqrt(3)*a1/4;
14 disp(r,"atomic radius = ");
```

Chapter 5

MILLER INDICES AND X RAY CRYSTALLOGRAPH TECHNIQUES

Scilab code Exa 5.1 Find MILLER INDICES OF THE PLANE

```
1  //Find MILLER INDICES OF THE PLANE
2  //Ex:5.1
3  clc;
4  clear;
5  close;
6  p=1;
7  q=1/2;
8  r=3;
9  h=1/p;
10 k=1/q;
11 l=1/r;
12 h1=3*h;
13 k1=3*k;
14 l1=3*l;
15 disp(h1,"MILLER INDICES OF THE PLANE are h =");
16 disp(k1,"k = ");
17 disp(l1,"l = ");
```

Scilab code Exa 5.3 Find MILLER INDICES OF THE PLANE

```
1 //Find MILLER INDICES OF THE PLANE
2 //Ex:5.3
3 clc;
4 clear;
5 close;
6 p=2/4;//intercepts
7 q=3/3;
8 r=4/2;
9 h=1/p;
10 k=1/q;
11 l=1/r;
12 h1=2*h;
13 k1=2*k;
14 l1=2*l;
15 disp(l1,k1,h1,"MILLER INDICES ARE ");
```

Scilab code Exa 5.5 Find interplanar Spacing

```
1 //Find Interplanar Spacing
2 //Ex:5.5
3 clc;
4 clear;
5 close;
6 r=1.246;//radius in angstorm
7 h=2;
```

```
k=0;
l=0;
x=sqrt(h^2+k^2+l^2);
a=2*sqrt(2)*r;//in angstorm
d_200=a/x;//interplanar spacing in angstorm
disp(d_200,"Interplanar Spacing (200) (in Angstorm)
   = ");
h1=2;
k1=2;
l1=0;
x1=sqrt(h1^2+k1^2+l1^2);
d_220=a/x1;//interplanar spacing in angstorm
disp(d_220,"Interplanar Spacing (220) (in Angstorm)
   = ");
h2=1;
k2=1;
l2=1;
x2=sqrt(h2^2+k2^2+l2^2);
d_111=a/x2;//interplanar spacing in angstorm
disp(d_111,"Interplanar Spacing (111) (in Angstorm)
   = ");
```

Scilab code Exa 5.6 Find Linear Density per unit length

```
//Find Linear Density per unit length
//Ex:5.6
clc;
clear;
close;
a=3.61*10^-10;//unit cell in m
r_110=2/(sqrt(2)*a);//in atoms/m
r_a=r_110/10^3;//in atoms/mm
disp(r_a,"Linear Density per unit length along
```

```
    direction [110] (in atoms/mm) =");
r_111=1/(sqrt(3)*a);//in atoms/m
r_b=r_111/10^3;//in atoms/mm
disp(r_b,"Linear Density per unit length along
    direction [111] (in atoms/mm) =");
```

Scilab code Exa 5.7 Find Planar Density

```
//Find Planar Density
//Ex:5.7
clc;
clear;
close;
r_po=1.7*10^-10;//radius of polonium in m
r_rh=1.34*10^-10;//radius of rhodium in m
r_cr=1.25*10^-10;//radius of chromium in m
a_po=2*r_po;//in m
a_rh=2*sqrt(2)*r_rh;//in m
a_cr=4*r_cr/sqrt(3);
p_po=1/a_po^2;// /sqm
disp(p_po,"Planar Density on [100] in Polonium (per
    sqm) = ");
p_rh=1.414/a_rh^2;// /sqm
disp(p_rh,"Planar Density on [110] in Rhodium (per
    sqm) = ");
p_cr=1.732/a_cr^2;// /sqm
disp(p_cr,"Planar Density on [111] in Chromium (per
    sqm) = ");
```

Scilab code Exa 5.8 Find Glancing angle and Interplanar spacing of the crystal

```
1 //Find Glancing angle and Interplanar spacing of the
      crystal
2 //Ex:5.8
3 clc;
4 clear;
5 close;
6 w=0.824;//wavelength in angstorm
7 a1=8.58;//angle at n=1 in degrees
8 n1=1;
9 n3=3;
10 a3=asind((n3/n1)*sind(a1));//angle at n=3 in degrees
11 disp(a3,"Glancing angle for third order diffraction
     = ");
12 d=w/(2*sind(a1));//in angstorm
13 disp(d,"Interplanar spacing of the crystal (in
     Angstorm) = ");
```

Scilab code Exa 5.9 Find Glancing angle and lattice parameter

```
1 //Find Glancing angle and lattice parameter
2 //Ex:5.9
3 clc;
4 clear;
5 close;
6 a=17.03;//in degrees
7 w=0.71;//in angstorm
8 n=1;
9 d=n*w/(2*sind(a));//interplanar spacing in angstorm
10 disp(d,"Interplanar Spacing (in angstorm) = ");
11 // given that h^2+k^2+l^2=8
```

```
12 a=sqrt(8)*d;//in angstorm
13 disp(a,"Lattice parameter of the crystal (in
      Angstorm) = ");
```

Scilab code Exa 5.10 Find Dimension of unit cell

```
1 //Find Dimension of unit cell
2 //Ex:5.10
3 clc;
4 clear;
5 close;
6 w=0.0708;//wavelength in nm
7 h=1;
8 k=0;
9 l=0;
10 s=0.0132;//a common divisor i.e.sin^2(theta)=0.0132
11 a=sqrt((w^2*(h^2+k^2+l^2))/(4*s));//in nm
12 a1=10^3*a;//in pm
13 disp(a1,"Dimension of unit cell (in Picometer) = ");
```

Chapter 6

IMPERFECTIONS DEFECTS AND DISLOCATIONS IN SOLIDS

Scilab code Exa 6.1 Find No of Frenkel defect

```
1  //Find No. of Frenkel defect
2  //Ex:6.1
3  clc;
4  clear;
5  close;
6  na=6.023*10^23;//Avagadro's no.
7  p=3170;//density in kg/m^3
8  mw=7.9*10^-2;//molecular weight of CaF2
9  nl=na*p/mw;//calcium ions/cubic m
10 ni=2*nl;// /cubic m
11 t=1300;//in K
12 ef=2.7*1.6*10^-19;//energy of formation of one
       frenkel defect
13 k=1.38*10^-23;//boltzmann constant
14 nf=sqrt(nl*ni)*exp(-ef/(2*k*t));//in /cubic m
15 disp(nf,"No. of Frenkel defect per unit volume of
       Calcium Fluoride (in /m^3) = ");
```

Scilab code Exa 6.2 Calculate Ratio of no of vacancies

```
1 //Calculate Ratio of no. of vacancies
2 //Ex:6.2
3 clc;
4 clear;
5 close;
6 r=8.314;// J/mol K
7 t1=300;//in K
8 ent=168*10^3;//enthalpy of formation of vacancy in J
    /mol
9 x1=exp(-ent/(r*t1));//x1=n/Na
10 t2=1000;//in K
11 x2=exp(-ent/(r*t2));//x2=n/Na
12 rt=x1/x2;//ratio
13 disp(rt,"Ratio of no. of vacancies = ");
```

Scilab code Exa 6.4 Find Elastic Strain Energy

```
1 //Find Elastic Strain Energy
2 //Ex:6.4
3 clc;
4 clear;
5 close;
6 v=0.31;//poisson's ratio
7 bv=.25*10^-9;//burger's vector in m
8 ri=1.1*10^-9;//in m
```

```
r0=10^5*bv;//in m
sm=45*10^9;//shear modulous in n/sqm
gb_2=sm*bv^2;
u_ed=(gb_2/(4*3.14*(1-v)))*log(r0/ri);
disp(u_ed,"Elastic Strain Energy of Edge dislocation
    (in J/m) = ");
u_sd=(gb_2/(4*3.14))*log(r0/ri);
disp(u_sd,"Elastic Strain Energy of Screw
   dislocation (in J/m) = ");
r=u_ed/u_sd;//ratio
disp(r,"Ratio of energies of edge dislocation over
   screw dislocation = ");
```

Scilab code Exa 6.5 Calulate Total number of created vacancies

```
//Calulate Total no. of created vacancies
//Ex:6.5
clc;
clear;
close;
r=1.7*10^-10;//atomic radius in m
n1=10^-3;//1mm=10^-3m
a=2*r;//in m
n=n1/a;
ed=2*10^-6;//edge dislocation in m
ns=ed/a;
nv=n*ns;
disp(nv,"Total no. of created vacancies = ");
```

Chapter 7

MECHANICAL PROPERTIES

Scilab code Exa 7.3 Find various Modulous of elasticity

```
1 //Find various Modulous of elasticity
2 //Ex7.3
3 clear;
4 close;
5 a1=222*10^9;//in N
6 a2=168*10^9;//in N
7 e1=1.90;//in sqm
8 e2=1.42;//in sqm
9 da=a1-a2;//in N
10 de=e1-e2;//in sqm
11 e_tan=da/de;
12 e_tann=e_tan*10^-9;//in Gpa
13 disp(e_tann,"Tangent Modulous of elasticity (in Gpa)
     = ");
14 a3=180*10^9;//in N
15 e3=1.46;//in sqm
16 e_sec=10^-9*a3/e3;//in Gpa
17 disp(e_sec,"Secant modulous of elasticity (in Gpa) =
     ");
18 a=85*10^6;
19 e=.68*10^-3;
```

```
20 e_y=10^-9*a/e;//in Gpa
21 disp(e_y,"Youngs modulous (in Gpa) = ");
```

Scilab code Exa 7.5 Find stress

```
1 //Find Stress
2 //Ex:7.5
3 clc;
4 clear;
5 close;
6 n=3;
7 a=300;
8 v_cr=2.8*10^-8;// in cm/cm/hour creep rate
9 x=log(v_cr)-n*log(a);
10 a1=exp(x);
11 t=365*24;//in hours
12 e=2*10^6;//kgf/sqcm
13 ai=750;//in kgf/sqcm
14 a_tf=sqrt(1/((1/ai^(n-1))+(a1*e*(n-1)*t)));
15 disp(a_tf,"Stress Remaining (in kgf/sq cm) = ");
```

Chapter 8

MECHANICAL TESTING

Scilab code Exa 8.1 Find Flexural Strength Shear Strength and Modulous of Rupture

```
1 //Find  Flexural Strength Shear Strength and
     Modulous of Rupture
2 //Ex:8.1
3 clc;
4 clear;
5 close;
6 b=225;//in mm
7 h=10;//in mm
8 l=1100;//in mm
9 f1=250;//in N
10 m=f1*l/4;//in N-mm
11 f=f1/2;//in N
12 a=(6*m)/(b*h^2);//in N/mm^2
13 disp(a,"Flexural Strength (in N/sqmm) = ");
14 t=(3*f)/(2*b*h);//in N/sqmm
15 disp(t,"Shear Strength (in N/sqmm) = ");
16 f2=350;//in N at which glass breaks
17 r=f2*l/4;//in N-mm
18 i=(b*h^3)/12;//in mm^4
19 y=h/2;//in mm
```

```
20 mr=r*y/i;//in n/sqmm
21 disp(mr,"Modulous of Rupture (in N/sqmm) = ");
```

Scilab code Exa 8.2 FIND BRINELL HARDNESS NUMBER

```
1 //FIND BRINELL HARDNESS NUMBER
2 //Ex:8.2
3 clc;
4 clear;
5 close;
6 d=5;//in mm
7 id=32.5/10;//indentation diameter in mm
8 p=30*d^2;//load for steel specimen in kgf
9 disp(p,"Load P for steel specimen (in kgf) = ");
10 bhn=p/((3.14*d/2)*(d-sqrt(d^2-id^2)));//in kgf/sqmm
11 disp(bhn,"BRINELL HARDNESS NUMBER of the steel
   specimen = ");
```

Scilab code Exa 8.3 Find Rupture Energy Modulous Of Rupture and Notch Imapct Strength

```
1 //Find Rupture Energy Modulous Of Rupture and Notch
   Imapct Strength
2 //Ex:8.3
3 clc;
4 clear;
5 close;
6 l=0.1;//frictinal and windage losses in kgf-m
7 dr=5.9;//dial reading in kgf-m
```

```
u=dr-l;//in kgf-m
disp(u,"Rupture Energy (in kgf-m) = ");
t=10;//in mm
d=t/5;//depth of V-notch in mm
te=t-d;//effective thickness in mm
ve=75*10*te;//effective volume in cu. mm
vem=ve*10^-9;//in cu. m
mr=u/vem;//in kgf/sqm
disp(mr,"Modulous Of Rupture (in kgf/sqm) = ");
ae=t*te;//effective area of cross section in sqmm
aem=ae*10^-6;//in sqm
is=u/aem;//in kg/m
disp(is,"Notch Imapct Strength (in kg/m) = ");
ui=30;//in kgf-m
a=160;//angle in degrees
r=0.8;//swing radius in m
uf=ui-u;//in kgf-m
w=19.33;//weight of hammer in kgf-m
hf=uf/w;//in m
disp(hf,"Height risen by Hammer (in m) = ");
//hf=r*(1-cos(b))
b=acosd((r-hf)/r);//in degrees
disp(b,"Angle after Breaking the specimen (in
   degress) = ");
```

Scilab code Exa 8.4 Find Stress Ratio and range

```
//Find Stress Ratio and range
//Ex:8.4
clc;
clear;
close;
a_m=70;//mean stress in Mpa
```

```
a_r=210;//stress amplitude in Mpa
a_max=((2*a_m)+a_r)/2;//maximum stress in MPa
disp(a_max,"Maximum Stress Level (in MPa) = ");
a_min=2*a_m-a_max;//Minimum stress in MPa
disp(a_min,"Minimum Stress Level (in MPa) = ");
s=a_min/a_max;//stress ratio
disp(s,"Stress Ratio = ");
sr=a_max-a_min;//stress range in MPa
disp(sr,"Stress Range (in MPa) = ");
```

Scilab code Exa 8.5 Calculate ENDURANCE STRESS FROM using various relations

```
//Calculate ENDURANCE STRESS FROM using various
   relations
//Ex:8.5
clc;
clear;
close;
p_min=20;//in kN
p_max=50;//in kN
l=500;//in mm
d=60;//in mm
a_u=650;//in MPa
a_y=520;;//in MPa
fos=1.8;//factor of safety
m_max=p_max*l/4;//maximum bending moment in kN mm
m_min=p_min*l/4;//minimum bending moment in kN mm
m_m=(m_max+m_min)/2;//mean bending moment in kN mm
m_a=(m_max-m_min)/2;//alternating bending moment in
   kN mm
z=3.14*d^3/32;
a_m=(m_m/z)*1000;//mean bending stress in MPa
```

```
19 a_a=(m_a/z)*1000;//alternating bending stress in MPa
20 a_e1=a_a/((1/fos)-(a_m/a_u)^2*fos);//in MPa
21 disp(a_e1,"ENDURANCE STRESS FROM Gerbers Parabolic
      Function (in MPa) = ");
22 a_e2=a_a/((1/fos)-(a_m/a_u));//in MPa
23 disp(a_e2,"ENDURANCE STRESS FROM Goodman Straight
      Line Relation (in MPa) = ")
24 a_e3=a_a/((1/fos)-(a_m/a_y));//in MPa
25 disp(a_e3,"ENDURANCE STRESS FROM Soderberg Straight
      Line Relation (in MPa) = ")
```

Chapter 9

MICROSTRUCTURAL EXAMINATION AND NON DESTRUCTIVE TESTING

Scilab code Exa 9.1 Find grain diameter

```
1 //Find grain diameter
2 //Exa:9.1
3 clc;
4 clear;
5 close ;
6 n=2^(12-1);//astm no.=12
7 //1 sq inch=645mm^2
8 d=1/sqrt((n/645)*10^4);//grain diameter in mm
9 disp(d,"grain diameter for ASTM no. 12 (in mm) = ");
```

Scilab code Exa 9.2 Find Average and Boundary area

```
1  //Find Average and Boundary area
2  //Exa:9.2
3  clc;
4  clear;
5  close ;
6  n=2^(5-1);//astm no. = 5 in grain/inch^2
7  //Lineal and Areal magnifications are related as
       *100 Lineal = *10000 Areal
8  x=n/(.01*.01);//in grain/inch^2 at 1 x.
9  a=1/x;//average area in inch^2
10 a1=2.54*2.54*a;//average area in cm.^2
11 disp(a1,"Average area of one grain (in sq cm) = ");
12 l=sqrt(x);//grains/inch of length
13 s=(1/l)^2;//surface area in sq inch
14 s6=6*s;//surface area of 6 surfaces of cubic grain
       in sq inch
15 b=0.5*s6*(l^3);//total boundary area in sq inch
16 b1=b/(2.54);//total boundary area in sq cm
17 disp(b1,"Boundary Area per cubic centimetre of steel
       (in sq cm) = ");
```

Chapter 10

PHASE DIAGRAM AND EQUILIBRIUM DIAGRAM

Scilab code Exa 10.1 Prove Two component system cannot have more than 4 phases in an equilibrium

```
1 //Prove Two component system cannot have more than 4
      phases in an equilibrium
2 //Exa:10.1
3 close;
4 clc;
5 clear;
6 c=2;//for 2 component system
7 disp("D=C-P+2");
8 disp("Total no. of variables = P*(C-1)+2");
9 p=4;
10 d=c-p+2;//degree of freedom
11 t=p*(c-1)+2;//no. of total variables
12 disp(d,"Degree of freedom = ");
13 disp(p,"when p = ");
14 disp("Two component system cannot have more than 4
     phases in an equilibrium");
```

Scilab code Exa 10.2 Calculate Total weight of lead and tin

```
1 //Calculate Total weight of lead and tin
2 //Exa:10.2
3 close;
4 clc;
5 clear;
6 p_pb=11364.1;//density of lead in kg/m^3
7 p_sn=7220.14;//density of tin in kg/m^3
8 p_e=100/((38/p_pb)+(62/p_sn));//density of eutectic
     composition at point D
9 disp(p_e,"Density of eutectic composition at point D
     (in kg/m3) = ");
10 w=.88*p_e;//in kgf
11 w_pb=.38*w;//of lead in kgf
12 w_sn=.62*w;//of tin in kgf
13 p_b=7300;//density in beta phase in kg/m^3
14 w1=.12*p_b;//in kgf
15 w1_pb=.03*w1;//of lead in kgf
16 w1_sn=.97*w1;//of tin in kgf
17 w2_pb=w_pb+w1_pb;//Total weight of lead in kgf
18 disp(w2_pb,"Total weight of lead (in kgf) = ");
19 w2_sn=w_sn+w1_sn;//Total weight of tin in kgf
20 disp(w2_sn,"Total weight of tin (in kgf) = ");
21 sn=(w2_sn/(w2_sn+w2_pb))*100;
22 disp(sn,"% of Sn = ");
```

Scilab code Exa 10.4 Find weight fractions

```
1 //Find weight fractions
2 //Ex:10.4
3 clc;
4 clear;
5 close;
6 c_be=100;
7 c_e=1.65;
8 c_o=10;
9 w=(c_be-c_o)/(c_be-c_e);
10 disp(w,"weight fractions = ");
```

Scilab code Exa 10.5 Find Maximum weight of tin

```
1 //Find Maximum weight of tin
2 //Ex:10.5
3 clc;
4 clear;
5 close;
6 //m be amount of tin
7 w_sn=900;//weight of tin
8 w_pb=1000;//weight of lead
9 m=((w_pb*0.97)-w_sn)/(1-.97);//in grams
10 m1=m/1000;//maximum mass of tin in kgm
11 disp(m1,"Maximum weight of tin that can be added
   without changing systems temperature (in kgm) = "
   );
```

Scilab code Exa 10.6 Find Weight fraction of errite and Cementite

```
1  //Find Weight fraction of errite and Cementite
2  //Ex:10.6
3  clc;
4  clear;
5  close;
6  c=0.83;//carbon
7  f=0;//ferrite
8  ce=6.67;//cementite
9  w_a=(ce-c)/(ce-f);
10 disp(w_a,"Weight fraction of errite = ");
11 w_b=(c-f)/(ce-f);
12 disp(w_b,"Weight Fraction of Cementite = ");
```

Chapter 12

HEAT TREATMENT

Scilab code Exa 12.1 calculate percentage change in volume

```
1 //calculate percentage change in volume
2 //Ex:12.1
3 clc;
4 clear;
5 close;
6 n_bcc=1/2;
7 n_fcc=1/4;
8 r_fcc=1.26;//in Angstorm
9 r_bcc=1.24;//in Angstorm
10 a_bcc=4*r_bcc/sqrt(3);//in Angstorm
11 a_fcc=2*sqrt(2)*r_fcc;//in Angstorm
12 v_fcc=a_fcc^3;
13 v_bcc=a_bcc^3;
14 v=100*((n_fcc*v_fcc)-(n_bcc*v_bcc))/(n_fcc*v_fcc);
15 disp(v,"Percentage change in volume = ");
```

Scilab code Exa 12.3 Estimate free energy change during recrystallization

```
//Estimate free energy change during
   recrystallization
//Ex:12.3
clc;
clear;
close;
e=51;//Young modulous in GPa
v=0.22;//poisson ratio
g=e/(2*(1-v));//shear modulous in GPa
b=2*10^-10;
ue=(1/2)*g*10^9*b^2*10^12;//in J/m^3
disp(ue,"Change in free energy during
   recrysatllization (in J/m^3) = ");
```

Scilab code Exa 12.5 Find contribution of particles

```
//Find contribution of particles
//Ex:12.5
clc;
clear;
close;
g=41*10^9;//in N/m^2
b=0.64*10^-9;//in m
l=20*10^-6;//in m
t=g*b/l;//in N/m^2
T=t*10^-6;//in MPa
disp(T,"Contribution of these particles (in MPa) = "
   );
```

Chapter 14

MAGNETIC PROPERTIES AND MATERIALS

Scilab code Exa 14.1 Find relative permeability and Intensity of magnetisation

```
1 //Find relative permeability and Intensity of
     magnetisation
2 //Ex:14.1
3 clc;
4 clear;
5 close;
6 x=1500;//susceptibility
7 h=2400;//mafnetic field in A/m
8 u_r=1+x;
9 disp(u_r,"relative permeability = ");
10 m=x*h;//in A/m
11 disp(m,"Intensity of magnetisation (in A/m)");
12 u_0=4*3.14*10^-7;
13 b=u_0*u_r*h;//in T
14 disp(b,"Remanance (in T) = ")
```

Scilab code Exa 14.2 Estimate Hysteresis energy loss per unit volume

```
1 //Estimate Hysteresis energy loss per unit volume
2 //Ex:14.2
3 clc;
4 clear;
5 close;
6 w=80+80;//width of loop in A/m from graph
7 h=0.15+.15;//height of loop in Wb/sqm
8 a=w*h;//area of the loop in J
9 disp(a,"Hysteresis energy loss per unit volume of
    magnetic material during one cycle (in J) = ");
```

Scilab code Exa 14.3 Find Power loss due to Hysteresis

```
1 //Find Power loss due to Hysteresis
2 //Ex:14.3
3 clc;
4 clear;
5 close;
6 a=600;//loop area in J/sqm
7 f=50;//in Hz
8 v=0.01//volume in cu. m
9 w=a*f*v;//in W
10 disp(w,"Power loss due to Hysteresis (in W) = ");
```

Scilab code Exa 14.4 Find Loss at 40 Hz

```
1 //Find Loss at 40 Hz
2 //Ex:14.4
3 clc;
4 clear;
5 close;
6 w_h1=300;
7 b_1=0.9;
8 y=b_1^1.7;
9 b_2=1.1;
10 x=b_2^1.7;
11 f1=50;
12 f2=40;
13 w_h2=(w_h1*x*f2)/(y*f1);
14 w_h22=w_h2*1.22;//in W
15 disp(w_h22,"Loss at 40 Hz (in W) = ");
```

Scilab code Exa 14.5 Find Magnetic strength

```
1 //Find Magnetic strength
2 //Ex:14.5
3 clc;
4 clear;
5 close;
6 m=6000;
7 u_r=200000;
8 x=u_r-1;
```

```
h=m/x;
u_0=4*3.14*10^-7;
b=u_0*u_r*h;
disp(b,"Magnetic strength (in T) = ");
```

Scilab code Exa 14.6 Estimate Saturation Magnetisation

```
//Estimate Saturation Magnetisation
//Ex:14.6
clc;
clear;
close;
b=9.27*10^-24;//Bohr Magneton in A/sqm
m=0.6*b;
a=0.35*10^-9;
n=4;//FCC
m_g=n*m/a^3;//in A/m
disp(m_g,"Saturation Magnetisation (in A/m) =");
```

Scilab code Exa 14.9 Find Eddy current loss at 60 and 100 Hz

```
//Find Eddy current loss at 60 and 100 Hz
//Ex:14.9
clc;
clear;
close;
f=50;//in Hz
L=100;//Eddy current loss in transformer in W
f1=60;//in Hz
```

```
w_e=L*(f1/f)^2;//in W
disp(w_e,"Eddy current loss at 60 Hz (in W) = ");
f2=100;//in Hz
w_ee=L*(f2/f)^2;//in W
disp(w_ee,"Eddy current loss at 100 Hz (in W) = ");
```

Scilab code Exa 14.13 Find Magnetic field strength and Flux density

```
//Find Magnetic field strength and Flux density
//Ex:14.13
clc;
clear;
close;
l=.25;//in m
n=400;//turns
i=15;//in A
u_0=1.257*10^-6;//in H/m
h=n*i/l;//in AT/m
disp(h,"Magnetic field strength (in AT/m) = ");
u_r=1;//relative permeability
b=u_0*u_r*h;//in wB/sqm
disp(b,"Flux density (in Wb/sq m) = ");
```

Chapter 15

ELECTRIC PROPERTIES

Scilab code Exa 15.1 Find Electric field

```
1 //Find  Electric field
2 //Ex:15.1
3 clc;
4 clear;
5 close;
6 v=230;//in volts
7 d=0.005;//in m
8 E=-v/d;//in V/m
9 disp(E,"Electric field between pair of conducting
    plates (in V/m) = ");
```

Scilab code Exa 15.2 Find Drift Velocity

```
1 //Find Drift Velocity
2 //Ex:15.2
3 clc;
4 clear;
```

```
close;
n=10^19;//no. of electrons per unit volume
e=1.602*10^-19;//charge of an electron in C
a=0.018;//conductivity in ohm/m
m=9.1*10^-31;//mass of an electron in kg
v=0.16;//in volts
t=0.29;//thickness in mm
efg=v/t;//electric field gradient in V/m
vd=a*efg/(n*e);
vd1=10^3*vd;//in m/s
disp(vd1,"Drift Velocity (in m/sec) = ");
```

Scilab code Exa 15.3 Find Specific Resistance

```
//Find Specific Resistance
//Ex:15.3
clc;
clear;
close;
l=200;//in m
r=21;//in ohm
d=0.44*10^-3;//in m
a=3.14*(d/2)^2;//area in sq m
p=r*a/l;//in ohm-m
disp(p,"Specific Resistance (in ohm-m) = ");
```

Scilab code Exa 15.4 Find Resistivity

```
//Find Resistivity
```

```
2 //Ex:15.4
3 clc;
4 clear;
5 close;
6 p_cu=0.015*10^-6;//resistivity of copper in ohm-m
7 p_ni=0.012*10^-6;//resistivity of nickel in ohm-m
8 p_ag=0.016*10^-6;//resistivity of silver in ohm-m
9 c1=0.25;//atomic % of nickel
10 c2=0.4;//atomic % of silver
11 p=p_cu+(c1*p_ni)+(c2*p_ag);
12 disp(p,"Resistivity of Cu-Ni-Ag alloy at 300 K (in
   ohm-m) = ");
```

Scilab code Exa 15.5 Calculate Intrinsic Carrier density

```
1 //Calculate Intrinsic Carrier density
2 //Ex:15.5
3 clc;
4 clear;
5 close;
6 m=0.14;//mobility of electron
7 u_h=0.05;//mobility of holes
8 p=3000;//resistivity in ohm-m
9 e=1.602*10^-19;//charge of an electron in C
10 a=1/p;//conductivity
11 n=a/(e*(m+u_h));
12 disp(n,"Intrinsic Carrier density in pure silicon (
   in per cu m) = ");
```

Scilab code Exa 15.6 Estimate Drift Velocity and time taken by electrons

```
1 //Estimate Drift Velocity and time taken by
     electrons
2 //Ex:15.6
3 clc;
4 clear;
5 close;
6 id=1000;//in A/sqm
7 p=0.05;//resistivity in ohm-m
8 l=100*10^-6;//in m
9 m_e=0.4;//in sqm/Vsec
10 e=1.602*10^-19;//charge of electron in C
11 a=1/p;//conductivity
12 n_e=a/(e*m_e);//in per cubic m
13 v_d=id/(n_e*e);//in m/s
14 disp(v_d,"Drift Velocity (in m/s) = ");
15 t=l/v_d;//in sec
16 t1=t*10^6;//in msec
17 disp(t1,"Time taken by electrons (in msec) = ");
```

Scilab code Exa 15.7 Find Impurity concentration

```
1 //Find Impurity concentration
2 //Ex:15.7
3 clc;
4 clear;
5 close;
6 d=1*10^-3;//diameter in m
7 a=3.14*(d/2)^2;//area of cross section of rod in sq
     m
8 r=100;//in ohm
9 l=10*10^-3;//in m
```

```
10 p=a*r/l;//in ohm-m
11 c=1/p;//conductivity
12 e=1.602*10^-19;//charge of electron in C
13 u_h=0.19;//mobility of holes in sqm/Vsec
14 n_h=c/(e*u_h);
15 disp(n_h,"Impurity concentration in rod (in per
     cubic m) = ");
```

Scilab code Exa 15.8 Calculate Conduction electron and hole density

```
1 //Calculate Conduction electron and hole density
2 //Ex:15.8
3 clc;
4 clear;
5 close;
6 ni=1.5*10^16;//intrinsic carrier concentration per
     cu. m
7 n=10^19;//no. of conduction electrons in per cu. m
8 p=ni^2/n;//in per cu.m
9 disp(p,"Conduction electron and hole density (per
     cubic m) = ");
```

Scilab code Exa 15.9 Calculate Hole concentration

```
1 //Calculate Hole concentration
2 //Ex:15.9
3 clc;
4 clear;
5 close;
```

```
nd=10^17;//in per cu cm
ni=1.5*10^10;//in cu cm
ne=nd;//nd>>ni
nh=ni^2/ne;
disp(nh,"Hole concentration (in per cubic cm) = ");
t=300;//in K
e=0.0259*log(ne/ni);//in eV
disp(e,"Location of Fermi Level (in eV) = ");
```

Scilab code Exa 15.10 Find thickness of insulation

```
//Find thickness of insulation
//Ex:15.10
clc;
clear;
close;
d=40000;//dielectric strength in V/mm
v=33*10^3;//in volts
t=v/d;//in mm
disp(t,"thickness of insulation (in mm) = ");
```

Scilab code Exa 15.16 Find Band gap energy

```
//Find Band gap energy
//Ex:15.16
clc;
clear;
close;
c=2.99*10^8;//speed of light in m/s
```

```
7  h=6.62*10^-24;//planck's constant
8  w=1.771*10^-6;//wavelength in J
9  eg=h*c/w;//in J
10 disp(eg,"Band gap energy (in J) = ");
```

Chapter 16

SUPERCONDUCTIVITY AND SUPERCONDUCTORS

Scilab code Exa 16.1 find susceptibilty and relative permeability of a superconductor

```
1 //find susceptibilty and relative permeability of a
     superconductor
2 //Ex:16.1
3 clc;
4 clear;
5 close;
6 b=0;
7 //m=-h
8 //m=x*h
9
10 //==>> -h=x*h
11 x=-1;//from above realtions
12 disp(x,"Susceptibility of superconductor = ");
13 ur=x+1;//relative permeability
14 disp(ur,"Relative permeability of superconductor = "
     );
```

Scilab code Exa 16.2 Determine critical field

```
1 //Determine critical field
2 //Ex:16.2
3 clc;
4 clear;
5 close;
6 ho=0.0803;//in A/m
7 t1=3;//in K
8 t2=10;//in k
9 tc=7.17;//in K
10 hc1=ho*(1-(t1/tc)^2);
11 disp(hc1,"Critical field at 3K (in A/m) = ");
12 hc2=ho*(1-(t2/tc)^2);
13 disp(hc2,"Critical field at 10K (in A/m) = ");
```

Scilab code Exa 16.3 Find critical current

```
1 //Find critical current
2 //Ex:16.3
3 clc;
4 clear;
5 close;
6 r=1*10^-3;//in m
7 hc=7.9*10^3;//in A/m
8 ic=2*3.14*r*hc;//in m
9 disp(ic,"Critical current in superconducting state (
    in A) = ");
```

Scilab code Exa 16.4 Find electron and current density

```
1 //Find electron and current density
2 //Ex:16.4
3 clc;
4 clear;
5 close;
6 p=11.4*10^3;//in kg/m^3
7 aw=207.2;//in kg/kg-mol
8 v=1200;//in m/s
9 na=60.23*10^26;//avagadro's no
10 e=1.6*10^-19;//charge in C
11 m=9.1*10^-31;//mass of electron in kg
12 mo=4*3.14*10^-7;//in H/m
13 ne=2*p*na/aw;//in per m^3
14 disp(ne,"Electron density (in per m^3) = ");
15 ied=ne*e*v;//in A/m^2
16 disp(ied,"Current density (in A/m^2) = ");
17 dp=(m/(mo*ne*(e^2)))^(1/2);
18 dp1=dp*10^10;
19 disp(dp1,"Depth of penetration (in angstorm) = ");
```

Scilab code Exa 16.9 determine critical current density

```
1 //determine critical current density
2 //Ex:16.9
3 clc;
```

```
clear;
close;
ho=65*10^3;//in A/m
tc=7.18;//in K
t=4.2;//in K
r=0.5*10^-3;//in m
hc=ho*(1-(t/tc)^2);//in A/m
ic=2*3.14*r*hc;//in A
a=3.14*r^2;//area in m^2
j=ic/a;//in A/m^2
disp(j,"current density (in A/m^2) = ");
```

Scilab code Exa 16.10 Determine transition temperature and critical field

```
//Determine transition temperature and critical
   field
//Ex:16.10
clc;
clear;
close;
hc1=21;//in A/m
hc2=10;//in A/m
tc=7;//in K
t=14;//in K
h=hc1/hc2;
//Determining critical temperature
tc1=sqrt(3626/11);//by quadratic eqn in the example
ho=hc1/(1-(tc^2/tc1^2));
disp(ho,"Critical field at 0 K (in A/m) = ");
t=4.2;//in k
hc=ho*(1-(t/tc1)^2);
disp(hc,"Critical field At 4.2 k (in A/m) = ");
```

Chapter 17

CERAMICS AND PLASTICS

Scilab code Exa 17.1 Calculate molecular weight

```
1 //Calculate molecular weight
2 //Ex:17.1
3 clc;
4 clear;
5 close;
6 mc=12;//mol wt of carbon
7 mh=1;;//mol wt of hydrogen
8 m=8*(mc+mh);//mol wt of C8H8
9 DOP=10000;//degree of polarization , given
10 mp=DOP*m;
11 disp(mp,"Molecualr weight of Styrene polymer = ");
```

Scilab code Exa 17.2 Determine molecular weight of teflon

```
1 //Determine molecular weight of teflon
2 //Ex:17.2
3 clc;
```

```
clear;
close;
DOP=10000;
mc=12;//mol wt of carbon
mf=19;;//mol wt of fluorine
m=(2*mc)+(4*mf);//mol wt of teflon monomer
mp=DOP*m;
disp(mp,"Molecualr weight of Teflon polymer = ");
mh=1;;//mol wt of hydrogen
m1=(2*mc)+(4*mh);//mol wt of polyethylene
//for same DOP
x=m/m1;//ratio of molecular weights
disp(x,"Ratio of molecualr weights of Teflon and
   Polyethylene = ");
```

Chapter 19

COMPOSITE MATERIALS

Scilab code Exa 19.1 Find flexural rigidity of sandwich construction

```
1 //Find flexural rigidity of sandwich construction
2 //Ex:19.1
3 clc;
4 clear;
5 close;
6 t_s=3;//in mm
7 t_c=24;//in mm
8 b=100;//in mm
9 d=(t_s+t_c)/2;//in mm
10 is=((b*t_s^3)/12)+(b*t_s*d^2);//in mm^4
11 ic=b*t_c^3/12;//in mm^4
12 m_p=7000;//moduli of polyester skin in N/mm^2
13 m_f=20;//moduli of foam core in N/mm^2
14 d_fr=(2*m_p*is)+(m_f*ic);//in N/mm^2
15 disp(d_fr,"Flexural rigidity (in N/sqm) = ");
```

Scilab code Exa 19.2 Determine volume ratio of Al and B in aluminium boron composite

```
1 //Determine volume ratio of Al and B in aluminium
     boron composite
2 //Ex:19.2
3 clc;
4 clear;
5 close;
6 ec=210;//in GPa
7 ea=71;//in GPa
8 eb=440;//in GPa
9 va=(ec-eb)/(ea-eb);
10 disp(va,"Va = ");
11 vb=1-va;
12 disp(vb,"Vb = ");
13 c=vb/va;
14 disp(c,"Volume ratio = ");
```

Scilab code Exa 19.3 Calculate fraction of load carried by fibres

```
1 //Calculate fraction of load carried by fibres
2 //Ex:19.3
3 clc;
4 clear;
5 close;
6 ef=430;//in GPa
7 e=3.6;//in GPa
8 m=ef/e;
9 vf=0.15;//by volume
10 vm=1-vf;
11 x=vm/vf;
12 pf=m;
```

```
pc=m+x;
y=pf/pc;
disp(y,"fraction of load carried by fibres (15 % by
    volume) = ");
vf1=0.65
vm1=1-vf1;
z=vm1/vf1;
pc1=m+z;
zz=pf/pc1;
disp(zz,"fraction of load carried by fibres (65 % by
    volume) = ")
```

Scilab code Exa 19.4 Find longitudinal strength longitudianl modulous transverse modulous Poisson ratio Shear modulous

```
//Find longitudinal strength longitudianl modulous
    transverse modulous Poisson ratio Shear modulous
//Ex:19.4
clc;
clear;
close;
vf=0.65;
vm=1-vf;
kts=2.8;//in Gpa
ets=0.0025;//in GPa
ac=(kts*vf)+(ets*vm);//in GPa
disp(ac,"Longitudinal Strength (in GPa) = ");
ktm=130;//in GPa
etm=3.5;//in GPa
ec=(ktm*vf)+(etm*vm);
disp(ec,"Longitudianl Modulous (in GPa) = ");
e_c=1/((vf/ktm)+(vm/etm));
disp(e_c,"Transverse Modulous (in GPa) = ");
```

```
18 kp=0.34;//in GPa
19 ep=0.36;//in GPa
20 vlt=(vf*kp)+(vm*vm);
21 disp(vlt,"Poissons Ratio = ");
22 glt=1/((vf/2.2)+(vm/1.2));//in GPa
23 disp(glt,"Shear Modulous (in GPa) = ");
```

Chapter 20

PERFORMANCE OF MATERIALS IN SERVICE

Scilab code Exa 20.1 Find fracture strength and ratio

```
1  //Find fracture strength and ratio
2  //Ex:20.1
3  clc;
4  clear;
5  close;
6  l=1.5*10^-6;//crack length in m
7  e=70*10^9;//Young's modulous in N/m^2
8  y_e=1.05;//specific surface energy in j/m^2
9  a_f=sqrt((2*y_e*e)/(3.14*l));
10 a_f1=a_f*10^-6;//in MPa
11 disp(a_f1,"Fracture strength (in MPa) = ");
12 r=a_f/e;//ratio
13 disp(r,"Ratio of fracture strength to Youngs
     modulous = " );
```

Scilab code Exa 20.2 Investigate an oxidation film will form over Nickel or not

```
1 //Investigate an oxidation film will form over
     Nickel or not
2 //Ex:20.2
3 clc;
4 clear;
5 close;
6 m_m=58.71;//molecular weight of ni
7 m_c=74.71;//molecular weight of nio
8 p_m=8900;//density of ni in kg/m^3
9 p_c=7080;//desity of nio in kg/m^3
10 x=m_m/p_m;//molar volume of ni in m^3/mol
11 disp(x,"Mc/Pc (in m^3/mol)");
12 y=m_c/p_c;//molar volume of nio in m^3/mol
13 disp(y,"Mm/Pm (in m^3/mol)");
14 printf("           Mc/Pc > Mm/Pm Hence protective
     layer of NiO will form over Ni        ");
```

Scilab code Exa 20.3 Find how much loss will occur in 300 hours

```
1 //Find how much loss will occur in 300 hours
2 //Ex:20.3
3 clc;
4 clear;
5 close;
6 x1=0.1;//in mm
7 t1=25;//in hours
8 t2=300;//in hours
9 x2=x1*sqrt(t2/t1);//in mm
10 disp(x2,"Oxidation loss in 300 hours (in mm) = ");
```

Scilab code Exa 20.4 Determine PBR ratio

```
1 //Determine PBR ratio
2 //Ex:20.4
3 clc;
4 clear;
5 close;
6 p_mg=1.74;//density of magnesium in gm/cm^3
7 p_mgo=3.65;//density of magnesium oxide in gm/cm^3
8 m_mg=24;//mol wt ogf mg
9 m_mgo=40.3;//mol wt of mgo
10 PBR=(m_mgo/p_mgo)/(m_mg/p_mg);
11 disp(PBR,"PBR = ");
12 printf("Since PBR < 1. So porous film will form
    which will be non protective");
```

Scilab code Exa 20.5 Find quantity of magnesium needed

```
1 //Find quantity of magnesium needed
2 //Ex:20.5
3 clc;
4 clear;
5 close;
6 m=0.0243;//one mole of magnesium in kg
7 c=2*96490;//in C
8 j=20*10^-3;//in A/m^2
9 t=15*365*24*3600;//in sec
10 x=j*t;//in A s
```

```
11 w_mg=m*x/c;//in kg/sqm
12 disp(w_mg,"Amount of Magnesium needed (in Kg/m^2) =
   ");
```

Chapter 21

DIFFUSION IN SOLIDS

Scilab code Exa 21.1 Find Concentration Gradient and diffusivity

```
1 //Find Concentration Gradient and diffusivity
2 //Ex:21.1
3 clc;
4 clear;
5 close;
6 c_cu=2*10^13;//concentration of copper in /m^3
7 c_al=4*10^6;//concn of copper on other side of Al in
      /m^3
8 t=3*10^-3;//thickness in m
9 z=(c_cu-c_al)/t;//z=dm/dx,concentration graient
10 disp(z,"Concentration Gradient (in /m^4) = ");
11 jx=10^21;//outward flux of copperv atoms in /sq m/
     sec
12 d=-jx/z;//diffusivity in sq m/sec
13 disp(d,"Diffusivity (in sq m/sec) = ");
```

Scilab code Exa 21.2 Find Concentration Gradient and diffusivity and rate

```
1 //Find Concentration Gradient and diffusivity and
     rate
2 //Ex:21.2
3 clc;
4 clear;
5 close;
6 c_n=12;//nitrogen concentration in kg/m^3
7 t=6*10^-3;//thickness in m
8 z=(c_n-0)/t;//concentration gradient in kg/m^4
9 disp(z,"concentration gradient (in kg/m4) = ");
10 d0=5*10^-7;//in sqm/sec
11 q=75*10^3;//in j/mol
12 r=8.314;//in J/mol/K
13 t=400;//in K
14 dx=d0*exp(-q/(r*t));//diffusivity in sqm/sec
15 disp(dx,"Diffusivity (in sqm/sec) = ");
16 jx=-z*dx;//rate of flow of nitrogen in kg/sqm/sec
17 disp(jx,"Rate at which nitrogen escapes (in kg/sqm/
     sec) = ");
```

Scilab code Exa 21.4 Calculate Activation Energy in Silver diffusion

```
1 //Calculate  Activation Energy in Silver diffusion
2 //Ex:21.4
3 clc;
4 clear;
5 close;
6 z=8;//ratio of diffusion in silicon at 1350 C and
     1100 C
7 x=log(z);
```

```
8  q=x/(1.35*10^-5);//activation energy for silver
      diffusion in J/mol
9  q1=q/1000;//in kJ/mol
10 disp(q1,"Activation Energy in Silver diffusion (in
      kJ/mol) = ");
```