Scilab Textbook Companion for Elements Of Thermal Technology by J. H. Seely[1]

Created by
Chaitanya Potti
Chemical Engineering
Chemical Engineering
IIT Bombay
College Teacher
NA
Cross-Checked by
Ganesh R

May 24, 2016

[1]Funded by a grant from the National Mission on Education through ICT, http://spoken-tutorial.org/NMEICT-Intro. This Textbook Companion and Scilab codes written in it can be downloaded from the "Textbook Companion Project" section at the website http://scilab.in

Book Description

Title: Elements Of Thermal Technology

Author: J. H. Seely

Publisher: Marcel Dekker Inc., New York, U. S. A.

Edition: 1

Year: 2002

ISBN: 0-8247-1174-2

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

Thermodynamic Definitions and Concepts

Scilab code Exa 1.1 Chapter 1 example 1

```
clc
//initialisation of variables
Vf= 0.019014 //ft^3/lbm
Vg= 1.4249 //ft^3/lbm
T= 425 //fahrenheit
quality= 60 //%
//CALCULATIONS
Vfg= Vg-Vf
V= (quality/100)*Vg+(1-(quality/100))*Vf
V1= Vf+(quality/100)*Vfg
V2= Vg-(1-(quality/100))*Vfg
//RESULTS
printf ('Vfg= %.4f ft^3/lbm',Vfg)
printf (' \n V= %.4f ft^3/lbm',V)
printf (' \n V= %.4f ft^3/lbm',V1)
printf (' \n V= %.4f ft^3/lbm',V2)
```

Scilab code Exa 1.2 Chapter 1 example 2

```
clc
//initialization of variables
tsat=431.82 //F
vf=0.019124 //ft^3/lbm
vg=1.3267 //ft^3/lbm
//Calculations
disp('From keenan and keyes steam tables, at 500 f
    and 350 psia,')
v=1.4913 //ft^3/lbm
//Results
printf('\n Specific volume = %.4f',v)
```

Scilab code Exa 1.3 Chapter 1 example 3

```
clc
//initialisation of variables
T= 100 //degrees
P= 200 //bar
//CALCULATIONS
Psat= 1.0135 //bar
Vf= 1.0435 //cm^3/gm
V= 1.0337 //cm^3/gm
v= Vf-V
//RESULTS
printf ('Amount of liquid compressed= %.4f cm^3/gm',
    v)
```

Chapter 2

Units and Dimensions

Scilab code Exa 2.1a Chapter 2 example 1a

```
clc
//initialisation of variables
F= 1//N
L= 1//m
T= 1//s
I= 1//N m s^2
N= 1//Kg m s^-2
//CALCULATIONS
I= F*L*T^2 //Kg m^2
//RESULTS
printf ('I in SI system= %.f Kg m^2',I)
```

Scilab code Exa 2.1b chapter 2 example 1b

```
clc
//initialisation of variables
F= 1//lbf
L= 1//ft
```

```
T= 1//s
I= 1//lbf ft s^2
lbf= 1//slug ft s^-2
//CALCULATIONS
I= F*L*T^2 //slug ft^2
//RESULTS
printf (' I in British Gravitational System = %.f
    slug ft^2',I)
```

Scilab code Exa 2.2 chapter 2 example 2

```
clc
//initialisation of variables
F= 1 //Pouunda
m= 1 //lbm
g= 1 //fts^-2
//CALCULATIONS
gc= m*g/F
//RESULTS
printf ('gc= %.2f lbm ft/poundal^2',gc)
```

Scilab code Exa 2.3 chapter 2 example 3

```
clc
//initialisation of variables
h= 76 //cmhg
g= 32.2 //ft/s^2
h= 76.0 //cmHg
Dhg= 847 //lbm/ft^3
//CALCULATIONS
Pa= Dhg*g*h*0.33
Pa1= Pa/1
//RESULTS
```

```
printf ('Pa= %.f poundal/ft^2',Pa1)
```

Chapter 3

Tem

Scilab code Exa 3.1 Chapter 3 example 1

```
clc
//initialisation of variables
T1= -3 //degrees
T2= 650 //Rankine
T3= 650 //Rankine
//CALCULATIONS
t1= (9/5)*T1+32
t2= T2-459.67
t21= (5/9)*(t2-32)
t3= t21+273.15
//RESULTS
printf ('T= %.2f F',t1)
printf (' \n T= %.2f C',t21)
printf (' \n T= %.2f K',t3)
```

Scilab code Exa 3.2 chapter 3 example 2

```
clc
```

```
//initialisation of variables
T1= 40 //degrees
T2= 30 //degrees
//CALCULATIONS
d1= (T1-T2)*(9/5)
d2= d1
//RESULTS
printf ('T= %.2f F',d1)
printf (' \n T= %.2f R',d2)
```

Scilab code Exa 3.3 chapter 3 example 3

```
clc
//initialisation of variables
l= 400 //mm
t1= 20 //degrees
t2= 90 //degrees
alpha= 19.3*10^-6 //degrees^-1
//CALCULATIONS
L= alpha*(t2-t1)*l
L1= L+l
//RESULTS
printf ('L= %.2f mm',L1)
```

Scilab code Exa 3.4 chapter 3 example 4

```
clc
//initialisation of variables
d= 2.98 //in
T1= 69 //F
T2= -15 //F
alpha= 22.7*10^-6 //C^-1
//CALCULATIONS
```

```
A0= %pi*d^2/4
alpha1= alpha/1.8
A= 2*alpha1*A0*(T1-T2)
A1= A0-A
d1= sqrt(4*A1/%pi)
//RESULTS
printf ('diameter at -15 = %.3f in',d1)
```

Chapter 4

viscosity

Scilab code Exa 4.1 Chapter 4 example 1

```
clc
//initialisation of variables
V= 1 //cp
//CALCULATIONS
SI= V*10^-2/10
BE= (V*10^-2*32.2)/(4.788*10^2)
RE= V*10^-2/(4.788*10^2*144)
//RESULTS
printf ('SI units= %.2e Pa s',SI)
printf (' \n BE units= %.2e lbm/ft s',BE)
printf (' \n Reyns units= %.2e reyn',RE)
```

Scilab code Exa 4.2 chapter 4 example 2

```
clc
//initialisation of variables
T= 68 //F
d= 1.0 //gm/cm^3
```

```
mu= 10^-2 //gm/cm s
SIm= 10^-4 //m^2/s
m= 10.76 //ft
//CALCULATIONS
SI= mu*SIm
BU= SI*m
//RESULTS
printf ('SI Units= %.2e m^2/s',SI)
printf (' \n British Units= %.2e ft/s',BU)
```

Scilab code Exa 4.3 chapter 4 example 3

```
clc
//initialisation of variables
Ku= 40 //SUS
//CALCULATIONS
SU= 0.0022*Ku-(1.8/Ku)
//RESULTS
printf ('Stoke Units= %.3f stoke',SU)
```

Scilab code Exa 4.4 chapter 4 example 4

```
clc
//initialisation of variables
v= 50 //fps
mu= 1.6*10^-4 //ft^2/s
d1= 10 //in
d2= 10 //in square
//CALACULATIONS
D= (%pi*4*d1^2/4)/(%pi*d2*12)
Re= (v*D)/mu
D1= (d1^2/(4*d2*3))
Re1= (v*D1)/mu
```

```
//RESULTS
printf ('Re= %.3e ',Re)
printf (' \n Re= %.3e ',Re1)
```

Scilab code Exa 4.5 chapter 4 example 5

```
clc
//initialisation of variables
v= 1.75*10^-3 //pa s
l= 1 //m
P= 1 //Mpa
d= 0.5 //mm
//CALCULATIONS
Q= (%pi*P*10^6*((d/2)*10^-3)^4)/(l*8*v)
//RESULTS
printf ('Q= %.2e Ns/m^2',Q)
```

Chapter 5

Surface Tension

Scilab code Exa 5.1 Chapter 5 example 1

```
clc
//initialisation of variables
St= 0.04 //N/m
d1= 5 //cm
d2= 15 //cm
//CALCULATIONS
W= St*10^3*2*4*%pi*((d2/2)^2-(d1/2)^2)
//REULTS
printf ('Work= %.2e dyn cm or erg',W)
```

Scilab code Exa 5.2 chapter 5 example 2

```
clc
//initialisation of variables
R= 0.017 //in
sigma= 72.8 //m N/m
//CALCULATIONS
P= (2*sigma*0.005*0.017)/(72.8*R*7.08*10^-4)
```

```
//REULTS
printf ('Presuure difference= %.1f lbf/ft^2',P)
```

Scilab code Exa 5.3 chapter 5 example 3

```
clc
//initialisation of variables
d= 13.6 //gm/cm^3
g= 980 //cm/s^2
D= 0.4 //mm
angle= 130 //degrees
s= 514 //dyn/cm
//CALCULATIONS
h= (4*s*cosd(angle))/(d*g*D*10^-1)
//RESULTS
printf (' Difference in mercury level= %.2f cm (
    depression)',h)
```

Chapter 6

work and heat

Scilab code Exa 6.1 Chapter 6 example 1

```
clc
//initialisation of variables
m= 5 //kg
h= 10 //m
gc= 1.0 //kg m/N s^2
//CALCULATIONS
v2= 2*h*gc*9.8
KE= (m*v2)/(2*gc)
PE= (m*gc*9.8*h)/(gc)
//RESULTS
printf ('KE= %.f J',KE)
printf (' \n PE= %.f J',PE)
```

Scilab code Exa 6.2 chapter 6 example 2

```
clc
//initialisation of variables
T= 149 //F
```

```
p= 20
//CALCULATIONS
h= 116.96+(p/100)*1008.7
//RESULTS
printf ('h= %.1f Btu/lbm',h)
```

Scilab code Exa 6.3 chapter 6 example 3

```
clc
//initialisation of variables
F= 30 //lb
w= 40 //lb
l= 10 //ft
t= 2 //sec
mu= 0.1
//CALCULATIONS
f= mu*w
W= F*l-f*l
FW= f*l
Fhp= FW/(550*t)
//RESULTS
printf ('Total work done= %.f ft lbf',W)
printf (' \n FW= %.f ft lbf',FW)
printf (' \n Frictional horsepower= %.3f hp',Fhp)
```

Scilab code Exa 6.4 chapter 6 example 4

```
clc
//initialisation of variables
N= 40 //lbf
mu= 0.1
l= 10 //ft
J= 778 //ft lbf/Btu
```

```
//CALCULATIONS
f= mu*N
FW= f*l
n= FW/J
//RESULTS
printf ('No of Btu involved= %.3f ft Btu',n)
```

Scilab code Exa 6.5 chapter 6 example 5

```
clc
//initialisation of variables
M= 50. //gm
T= 98. //C
Mw= 75. //gm
T1= 19. //C
Tm= 27. //C
Mc= 123. //gm
SH= 0.1 //cal gm^-1 C^-1
Qinst= 6.5 //cal
//CALCULATIONS
c= (Mc*SH+Mw+Qinst)/(M*(T-Tm))
//RESULTS
printf ('Mean specific heat of the metal sample= %.4
   f cal/C gm',c)
//The answer given in textbook is Wrong
```

Scilab code Exa 6.6 chapter 6 example 6

```
clc
//initialisation of variables
Mw= 500 //gm
Tw= 80 //C
Ti= -4 //F
```

```
Tf= 50 //C
ci= 0.5 //cal/gm
L= 79.7 //cal/gm
cw= 1 //cal/gm
Dt= Tw-Tf
//CALCULATIONS
Tf1= (5/9)*(Ti-32)
Dt1= Tf1-Tf
m= (Mw*cw*Dt)/(ci*(-Dt1)+L)
//RESULTS
printf ('Grams of ice can be added= %.f gm',m)
```

Chapter 7

First Law of Thermodynamics

Scilab code Exa 7.1 Chapter 7 example 1

```
clc
//initialisation of variables
m= 3000 //lb
Z1= 50 //ft
V1= 50 //mph
gc= 32.2 //ft/lbf s^2
V2= 0 //mph
g= 32.2 //ft/s^2
Z2= 0 //ft
//CALCULATIONS
V1= V1*(73.3/50)
Q2= ((m*(V2^2-V1^2))/(2*gc))+((m*g)/gc)*(Z2-Z1)
//RESULTS
printf ('Energy dissipated from the brakes= %.e ft
    lbf',-Q2)
```

Scilab code Exa 7.2 chapter 7 example 2

```
clc
//initialisation of variables
P= 15 //bar
T= 300 //C
h1= 3043.1 //J/gm
//CALCULATIONS
u2= h1
T= 453.4
//RESULTS
printf ('Temperature of the steam in the tank= %.1f
   C',T)
```

Scilab code Exa 7.3 chapter 7 example 3

```
clc
//initialisation of variables
m= 10 //lbf
T= 120 //F
T1= 275 //F
u1= 98.9 //Btu/lbm
u2= 125.6 //Btu/lbm
//CALCULATIONS
Q= m*(u2-u1)
//RESULTS
printf ('Heat transferred to the tank= %.f Btu',Q)
```

Scilab code Exa 7.4 chapter 7 example 4

```
clc
//initialisation of variables
v0= 1 //m/s
vi= 60 //m/s
Q= -500 //J/s
```

```
m= 500 //gm/s
hi= 2000 //J/gm
h0= 1800 //J/gm
zi= 3 //m
z0= 0 //m
g= 9.8 //m/s^2
gc= 10^3 //gm m/Ns^2
//CALCULATIONS
W= Q+m*((hi-h0)+(vi^2-v0^2)/(2*gc)+(g/gc)*(zi-z0))
//RESULTS
printf ('Maximum theotrical power that can be
    devoloped= %.e J/s',W)
```

Scilab code Exa 7.5 chapter 7 example 5

```
clc
//initialisation of variables
m= 0.3 //lt/s
T= 82 //C
P= 2.4 //bar
p= 80
Tw= 800 //C
h1= 67.19 //J/gm
h3= 343.3 //J/gm
hf= 529.65 //J/gm
hfg= 2185.4 //J/gm
v3= 1.0305 //cm^3/gm
V3= 300 //cm^3/s
//CALCULATIONS
h2= hf+(p/100)*hfg
m3= V3/v3
m2= (m3*(h3-h1))/(h2-h1)
//RESULTS
printf ('Required steam flow rate= %.1f gm/s',m2)
```

Scilab code Exa 7.6 Chapter 7 example 6

```
clc
//initialisation of variables
h2= 2 //J/gm
h1= 1 //J/gm
//CALCULATIONS
L= h2-h1
//RESULTS
printf ('Difference between the enthalpies of the
   system in the two phases= %.f (h2-h1) J/gm',L)
```

Chapter 8

Second Law of Thermodynamics

Scilab code Exa 8.1 Chapter 8 example 1

```
clc
//initialisation of variables
W= 25 //Btu
W1= 100 //Btu
T1= 140 //R
T2= 0 //R
//CALCULATIONS
Th= T1+460
Tl= T2+460
nt= (Th-Tl)/Th
n= nt*100
//RESULTS
printf ('maximum theotrical efficiency= %.1f (Claim
    is not valid)',n)
```

Scilab code Exa 8.2 chapter 8 example 2

```
clc
//initialisation of variables
P= 10 //bar
P1= 38 //bar
T= 310 //C
v= 64.03 //cm^3/gm
s= 6.4415 //J/gm K
vf= 1.12773 //cm^3/gm
vg= 194.44 //cm^3/gm
sf= 2.1387 //J/gm K
sfg= 4.4478 //J/gm K
//CALCULATIONS
x= (v-vf)/(vg-vf)
sx= sf+x*sfg
S= s-sx
//RESULTS
printf ('Change in Entropy= %.3f J/gm',S)
```

Scilab code Exa 8.3 chapter 8 example 3

```
clc
//initialisation of variables
Qh= 70000 //Btu/hr
T= 15 //F
T1= 72 //F
//CALCULATIONS
COP= (T1+460)/((T1+460)-(T+460))
W= Qh/COP
//RESULTS
printf ('Minimum power required to drive the heat
    pump= %.f Btu/hr',W)
```

Scilab code Exa 8.4 chapter 8 example 4

```
clc
//initialisation of variables
h= 26 //KW
T= 43 //C
To= 0 //C
//CALCULATIONS
COP= (T+273)/((T+273)-(To+273))
W= h/COP
Qh=h
//RESULTS
printf ('Minimum electrical  requirement = %.2f KW',
   W)
printf (' \n Elctrical requirement if an electrical
   heater used= %.f KW',Qh)
```

Chapter 9

Gas Properties and Processes

Scilab code Exa 9.1 Chapter 9 example 1

```
clc
//initialisation of variables
v= 15 //ft^3
m= 20 //lbm
T= 80 //lbf
P= 320 //psia
//CALCULATIONS
R= P*144*v/(m*(T+460))
M= 1545/R
//RESULTS
printf ('Molecular weight of the gas = %.1f lbm/lbm
   mol',M)
```

Scilab code Exa 9.2 chapter 9 example 2

```
clc
//initialisation of variables
V= 50 //lit
```

```
P= 20 //atm
T= 30 //C
P1= 6 //atm
T1= 10 //C
M= 32 //gm/gm mol
//CALCULATIONS
n= V*P/(0.082*(T+273))
m= n*M
n2= P1*V/(0.082*(T1+273))
m2= n2*M
//RESULTS
printf ('Initial Mass of Oxygen = %.f gm ',m)
printf (' \n Final mass of oxygen= %.f gm',m2)
```

Scilab code Exa 9.3 chapter 9 example 3

```
clc
//initialisation of variables
V2= 0.75 //ft^3
P2= 1 //atm
P1= 3 //atm
T= 35 //F
e= 1.3
//CALCULATIONS
V1= ((P2*(V2)^e)/P1)^(1/e)
T2= P1*V1*(T+460)/(P2*V2)
//RESULTS
printf ('Final volume = %.2f ft^3 ',V2)
printf (' \n Final temperature= %.f R',T2)
//The answer is approximated in the textbook
```

Scilab code Exa 9.4 chapter 9 example 4

```
clc
//initialisation of variables
m= 0.45 //kg
v1= 0.03 //m^3
v2= 0.06 //m^3
P= 6.9*10^5 //Pa
K= 1.4
R= 287.1 //J/Kg K
//CALCULATIONS
T1= (P*v1)/(m*R)
T2= T1
P2= P*v1/v2
T3= T2*(v2/v1)^(K-1)
P3= P2*(v2/v1)^K
//RESULTS
printf ('T1 = %.f K ',T1)
printf (' \n T2= %.f K',T2)
printf (' \n T3= %.f K',T3)
printf (' \n P2= %.2e Pa',P2)
printf (' \n P3= %.2e Pa',P3)
```

Scilab code Exa 9.5 chapter 9 example 5

```
clc
//initialisation of variables
P= 1 //atm
T= 60 //F
P1= 4 //atm
e= 1.3
R= 55.15 //lbf/lbm R
m= 778
//CALCULATIONS
T2= (T+460)*(P1/P)^((e-1)/e)
W= R*(T2-(T+460))/(1-e)
W1= W/m
```

```
//RESLUTS
printf ('Work associated with the process= %.1f Btu/
   lbm ',W1)
```

Scilab code Exa 9.6 chapter 9 example 6

```
clc
//initialisation of variables
m= 10//lbm
R= 48.28 //lbf/lbm R
T= 120 //F
V= 150 //ft^3
m1= 15 //lbm
R1= 55.15 //lbf/lbm R
//CALCULATIONS
P1= (m*R*(T+460))/V
P2= (m1*R1*(T+460))/V
Pm= P1+P2
V1= (m*R*(T+460))/Pm
V2= (m1*R1*(T+460))/Pm
Vm= V1+V2
//RESULTS
printf ('Total volume= %.f ft^3 ',Vm)
```

Chapter 10

Combustion Processes

Scilab code Exa 10.1 Chapter 10 example 1

```
clc
//initialisation of variables
n= 3 //lbm mol
Mo2= 32 //lbm/lbm mol
//CALCULATIONS
m= n*Mo2
//RESULTS
printf ('Mass of O2 required= %.f lbm ',m)
```

Scilab code Exa 10.2 chapter 10 example 2

```
clc
//initialisation of variables
n= 3 //lbm mol
Mo2= 32 //lbm/lbm mol
//CALCULATIONS
m= n*Mo2
//RESULTS
printf ('Mass of O2 required= %.f lbm ',m)
```

Scilab code Exa 10.3 chapter 10 example 3

```
clc
//initialisation of variables
n= 12.5 //mol
n1= 3.76 //mol
M= 114 //gm/gm mol
M1= 28.96 //gm/gm mol
//CALCULATIONS
n2= n*(1+n1)
m= n2*M1/M
//RESULTS
printf ('Air-fuel ratio= %.1f gm air/gm fuel',m)
```

Scilab code Exa 10.4 chapter 10 example 4

```
clc
//initialisation of variables
p= 150
nO2= 12.5 //mol
n1= 3.76
//CALCULATIONS
n2= (nO2*(p/100))+(nO2*n1*(p/100))
//RESULTS
printf ('Air-fuel raio= %.2f kg mol air/kg mol fuel'
    ,n2)
```

Scilab code Exa 10.5 chapter 10 example 5

```
clc
//initialisation of variables
P= 65
T= 30 //C
T1= 10 //C
c= 4.19 //J/gm C
h= 41961
m= 185 //lt
//CALCULATIONS
Q= m*10^3*c*(T-T1)
M= (Q*100)/(h*P)
//RESULTS
printf ('Benzene required= %.f gm',M)
```

Chapter 11

Conduction Heat Transfer

Scilab code Exa 11.1 Chapter 11 example 1

```
clc
//initialisation of variables
T= 76 //F
T1= 21 //F
Tw= 67 //W
h= 1.5 //Btu/
A= 1 //ft^2
h0= 6.5 //Btu/hr
//CALCULATIONS
q= h*A*(T-Tw)
t= (q/(h0*A))+T1
//results
printf ('Outside wall temperature= %.1f F',t)
```

Scilab code Exa 11.2 chapter 11 example 2

```
clc
//initialisation of variables
```

```
hi= 2 //Btu/hr ft^2 F
l= 6 //in
k= 0.5 //Btu/hr ft F
h0= 10 //Btu/hr ft^2 F
ti= 70 //F
t0= 20 //F
A= 1 //ft^2
//CALCULATIONS
U= 1/((1/hi)+((l*0.5)/(6*k))+(1/h0))
q= U*A*(ti-t0)
//RESULTS
printf ('Thermal transmittance= %.2f ft^2 F',U)
printf (' \n Heat transfer rate= %.1f Btu/hr',q)
```

Scilab code Exa 11.3 chapter 11 example 3

```
clc
//initialisation of variables
Ti= 300 //F
T0= 100 //F
l= 0.25 //in
li= 3 //in
A= 12 //in/ft
ks= 31.4 //Btu/hr ft F
ki= 0.04 //Btu/hr ft F
//CALCULATIONS
q= (Ti-T0)/((l/(A*ks))+(li/(A*ki)))
t= Ti-((q*l/12)/ks)
//RESULTS
printf ('Heat loss= %.f Btu/hr',q)
printf (' \n Temperature at the interface of the
    steel and the insulation= %.2f F',t)
```

Scilab code Exa 11.4 chapter 11 example 4

```
clc
//initialisation of variables
ti= 149 //C
t0= 27 //C
D0= 0.1149 //m
l= 1 //m
h0= 23 //W/m^2 C
hi= 227 //W/m^2 C
k= 0.19 //W/m C
Di= 0.0889 //cm
//CALCULATIONS
D1= D0*100
D2= Di*100
R0=(1/(D0*%pi*l*h0))
Rins=(log(D1/D2)/(2*%pi*k*l))
Ri=1/(Di*%pi*l*hi)
q= (ti-t0)/(R0+Rins+Ri)
//RESULTS
printf ('Heat loss= %.f W',q)
```

Scilab code Exa 11.5 chapter 11 example 5

```
clc
//initialisation of variables
l= 0.2 //m
l1= 0.5 //m
k= 0.35 //W/m C
t= 0.15 //m
T1= 1100 //C
T2= 150 //C
//CALCULATIONS
Ai= 6*l^2
Ao= 6*l1^2
```

```
q= 0.73*k*sqrt(Ai*Ao)*(T1-T2)/t
//RESULTS
printf ('Power consumption= %.f W',q)
```

Scilab code Exa 11.6 chapter 11 example 6

```
clc
//initialisation of variables
h= 12 //W/m^2 C
k= 0.19 //W/m C
d= 0.6 //m
//CALCULATIONS
r= k/h
d1=d/2
if (r<d1)
    printf('heat loss will increase if the insulation is added');
else
    printf('heat loss will increase if the insulation is added');
end
```

Scilab code Exa 11.7 chapter 11 example 7

```
clc
//initialisation of variables
h= 85 //W/m^2 C
s= 0.15 //m
K= 225 //W/m C
t= 510 //C
t1= 1200 //C
t0= 16 //C
a= 0.34
```

```
//CALCULATIONS
Bi= h*s/K
T= K*s*log((t0-t1)/(t-t1))/(h*a)
//RESULTS
printf ('Time needed for the casting to be heated to
    510 C= %.2f hr',T)
```

Chapter 12

Convection Heat Transfer1

Scilab code Exa 12.1 Chapter 12 example 1

```
clc
//initialisation of variables
d= 5 //ft
Tw= 150 //F
T= 50 //F
Pr= 0.72
k= 0.015 //Btu/hr ft F
r= 1.76*10^6 //(F ft^3)^-1
//CALCULATIONS
D= d*(0.42/5)
dt= Tw-T
Gr= r*D^3*dt
z= Gr*Pr
h= 0.59*(z^(0.25)) *(k/D)
disp(h)
q= (2*h*dt*d^2)/144
//RESULTS
printf ('Heat transfer rate from both sides of the
    plate= %.2f Btu/hr',q)
//The answer given in the textbook has been rounded
    off at several places.
```

```
//Hence it differs from the one in the code.
```

Scilab code Exa 12.2 chapter 12 example 2

```
clc
//initialisation of variables
T= 70 //F
l= 0.9 //in
v= 7 //ft/s
d= 62.3 //lbm/ft^3
m= 6.58*10^-4 //lbm/ft s
Pr= 6.82
k= 0.347 //Bt/hr ft F
//CALCULATIONS
l1= l*0.075/l
Re= (d*v*l1)/m
Nu= 0.023*Re^0.8*Pr^0.4
h= Nu*k/l1
//RESULTS
printf ('Heat transfer coefficient when the flow is
   fully devoloped= %.f Btu/hr ft^2 F',h)
```

Scilab code Exa 12.3 chapter 12 example 3

```
clc
//initialisation of variables
P= 1 //atm
d= 0.783 //Kg/m^3
K= 0.0371 //W/m C
m= 2.48*10^-5 //Ns/m^2
Pr= 0.683
D= 0.03 //m
v= 6 //m/s
```

```
T= 10 //C
//CALCULATIONS
Re= d*v*D/m
Nu= 0.023*Re^0.8*Pr^0.4
h= Nu*K/D
ql= h*%pi*D*T
//RESULTS
printf ('Heat transfer rate per unit lenght= %.1f W/
    m',ql)
```

Scilab code Exa 12.4 chapter 12 example 4

```
clc
//initialisation of variables
T= 25 //C
P= 1 //atm
v= 46 //m/s
d= 5 //cm
T1= 135 //C
d1= 0.998 //kg/m^3
k= 0.03 //W/m C
m= 2.08*10^-5 //Kg/s m
c= 0.024
n= 0.81
//CALCULATIONS
Tf= (T+T1)/2
D= d/100
Re= d1*v*D/m
h= c*Re^0.81*k/D
dt= T1-T
ql= h*%pi*D*dt
//RESULTS
printf ('Heat transfer rate per unit lenght of
    cylinder= %.f W/m',ql)
```

Chapter 13

Boiling Heat Transfer

Scilab code Exa 13.1 Chapter 13 example 1

```
clc
//initialisation of variables
P= 1 //atm
dt= 11 //C
Csf= 0.006
r= 1/3
s= 1
cl= 4.218 //J/gm K
hfg= 2257 //J/gm
Pr= 1.75
ul= 283.1*10^-3 //gm/m s
s= 57.78*10^-3 //N/m
pl= 958*10^3 //gm/m^3
pv= 598 //gm/m^3
gc= 10^3 //gm m/N s^2
g= 9.8 //m/s^2
//CALCULATIONS
p= pl-pv
q= ((((cl*dt)/(hfg*Csf*Pr))^(1/r))*(ul*hfg))/(gc*s/(
    g*p))^(1/2)
h= q/dt
```

```
//RESULTS
printf ('Heat transfer coefficient for nucleate
   boiling= %.2e W/m^2 C',h)
```

Scilab code Exa 13.2 chapter 13 example 2

```
clc
//initialisation of variables
k= 0.384 //Btu/hr ft F
Tsat= 170.03 //F
hfg= 996.2 //Btu/lbm
T= 130 //F
l= 5 //ft
P= 6 //psia
g= 4.17*10^8 //ft/h^2
d= 0.042 //ft
p= 61.2 //lbm/ft^3
u= 1.05 //lbm/ft h
//CALCULATIONS
dt= Tsat-T
Tf= (Tsat+T)/2
hc= 0.943*((k^3*p^2*g*hfg)/(l*u*dt))^(1/4)
hc1= 0.725*((k^3*p^2*g*hfg)/(d*u*dt))^(1/4)
//RESULTS
printf ('Condensation heat tranfer coefficient if
   the tube is vertical= %.f Btu/h ft^2 F',hc)
printf (' \n Condensation heat tranfer coefficient
   if the tube is horizontally= %.f Btu/h ft^2 F',
   hc1)
```

Chapter 14

Radiation Heat Transfer

Scilab code Exa 14.2 Chapter 14 example 2

```
clc
//initialisation of variables
T= 116 //C
C1= 3.74*10^-16
C2= 1.44*10^-2
//CALCULATIONS
WLmax= (2893*10^-6)/(T+273)
Wb= (C1*(WLmax)^(-5))/((%e^(C2/2893*10^6))-1)
//RESULTS
printf ('Wavelength at which the maximum
    monochromatic emissive power = %.2e m',WLmax)
printf (' \n Coffecient of performnance= %.2e W/m^3'
    ,Wb)
```

Scilab code Exa 14.3 chapter 14 example 3

```
clc
//initialisation of variables
```

```
T= 389 //K
s= 5.7*10^-8 //K^4
//CALCULATIONS
Wb= s*T^4
//RESULTS
printf ('Emissive power for the blackbody = %.f W/m
   ^2',Wb)
```

Scilab code Exa 14.4 chapter 14 example 4

```
clc
//initialisation of variables
T= 100 //F
T1= 2000 //F
W= 3.2*10^4 //Btu/hr ft^2
W1= 140 //Btu/hr ft^2
s= 0.17*10^-8 //Btu/hr ft^2 R^4
//CALCULATIONS
alpha= W/(s*(T1+460)^4)
b= W1/(s*(T+460)^4)
//RESULTS
printf ('Average absorptivity of the body at 100 F =
   %.2f ',alpha)
printf (' \n Average absorptivity of the body at
   2000 F= %.2f ',b)
```

Scilab code Exa 14.5 chapter 14 example 5

```
clc
//initialisation of variables
T= 300 //F
T1= 50 //F
s= 0.17*10^-8 //Btu/hr ft^2 R^4
```

```
e1= 0.93
A= 10 //in
F= 1
//CALCULATIONS
A1= 10*(40/(12*10))
q= A1*F*e1*s*((T+460)^4-(T1+460)^4)
//RESULTS
printf ('Heat loss from the conduit by radiation = %
    .f Btu/hr per ft',q)
```

Scilab code Exa 14.6 chapter 14 example 6

```
clc
//initialisation of variables
T= 300 //F
T1= 50 //F
s= 0.17*10^-8 //Btu/hr ft^2 R^4
e1= 0.93
F= 1
//CALCULATIONS
hr= F*e1*s*((T+460)^4-(T1+460)^4)/(T-T1)
//RESULTS
printf ('Radiation heat transfer coefficient= %.2f
    Btu/hr ft^2 R',hr)
```

Scilab code Exa 14.7 chapter 14 example 7

```
clc
//initialisation of variables
P= 1 //atm
T= 11 //C
Csf= 0.006
r= 1/3
```

```
s= 1
cl= 4.218 //J/gm K
hfg= 2257 //J/gm
Pr= 1.75
ul= 283.1*10^-3 //gm/m s
s= 57.78*10^-3 //N/m
pl= 958*10^3 //gm/m^3
pv= 598 //gm/m^3
gc= 10^3 //gm m/N s^2
g= 9.8 //m/s^2
//CALCULATIONS
p= pl-pv
q= ((((cl*dt)/(hfg*Csf*Pr^s))^(1/r))*(ul*hfg))/(gc/(
   g*p))^(1/2)
h= q/T
//RESULTS
printf('Heat transfer coefficient for nucleate
   boiling= %.2e W/m^2 C',h)
```

Chapter 15

Refrigeration and Air Conditioning

Scilab code Exa 15.1 Chapter 15 example 1

```
clc
//initialisation of variables
P= 7 //bar
P1= 1.4 //bar
T= 260 //C
T1= 251 //C
h= 2974.9 //J/gm
//CALCULATIONS
dT= T-T1
Mj= dT/(P-P1)
//RESULTS
printf ('Joule-Thomson coefficient= %.2f C/bar ',Mj)
```

Scilab code Exa 15.2 chapter 15 example 2

```
clc
```

```
//initialisation of variables
T= 10 //F
T1= 110 //F
Pr= 180 //lbm/hr
h1= 78.335 //Btu/lbm
h3= 33.531 //Btu/lbm
h2= 91 //Btu/lbm
L= 12000 //Btu/hr per ton
//CALCULATIONS
h4= h3
QL= h1-h4
W= h2-h1
COP= QL/W
C= QL*Pr/L
//RESULTS
printf ('Refrigerating effect = %.1f Btu/lbm ',QL)
printf (' \n Coffecient of performnance= %.1f ',COP)
printf (' \n Capacity of refrigeration in tons= %.2f
    ton',C)
```