Scilab Textbook Companion for Introduction To Thermodynamics And Heat Transfer by D. A. Mooney[1]

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Book Description

Title: Introduction To Thermodynamics And Heat Transfer

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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 2

Work

Scilab code Exa 2.1 chapter 2 example 1

```
clc
//initialisation of variables
P= 100 //psia
V= 3 //cu ft
P1= 20 //psia
n= 1.4
//CALCULATIONS
V1= V*(P/P1)^(1/n)
W= (P1*V1*144-P*V*144)/(1-n)
//RESULTS
printf ('P dV work for this process= %.f ft lb',W)
```

Scilab code Exa 2.2 chapter 2 example 2

```
clc
//initialisation of variables
W= 1 //hp
P= 69.4 //psia
```

```
V2= 3 //cu
V1= 1 //cu
//CALCULATIONS
Wb=  -W*33000
Wa= P*(V2-V1)*144
Q= Wa+Wb
//RESULTS
printf ('Total system work during the 1 minute
    period= %.f ft lb',Q)
```

Scilab code Exa 2.3 chapter 2 example 3

```
clc
//initialisation of variables
r= 11 //in
l= 15 //in
A= 1.6 //in
l1= 2.4 //in
//CALCULATIONS
a= %pi*r^2/4
L= l/12
Pm= (A/l1)*80
W= a*L*Pm
//RESULTS
printf ('Net work done by the fluid in the cylinder=
    %.f ft lb',W)
```

Chapter 3

Temperature and Heat

Scilab code Exa 3.1 chapter 3 example 1

```
clc
//initialisation of variables
T2w= 100 //F
T1w= 75 //F
cw= 1 //Btu/lb F
T2i= 100 //F
T1i= 500 //F
ci= 0.12 //Btu/lb F
mi= 1
//CALCULATIONS
Mw= -mi*ci*(T2i-T1i)/(cw*(T2w-T1w))
//RESULTS
printf ('Pounds of water needed per pound of iron= %
    .2f lb water/lb iron',Mw)
```

Scilab code Exa 3.2 chapter 3 example 2

```
clc
```

```
//initialisation of variables
m=5 //lb
T1=1540 +460 //R
T2=540+460 //R
//CALCULATIONS
function [cp]=cp(T)
    cp=0.248+0.448*10^-8 *T*T
endfunction
Q=m*intg(T1,T2,cp)
//Results
printf ('Net heat transferred to the system = %.2f
   Btu',Q)
```

Scilab code Exa 3.3 chapter 3 example 3

```
clc
//initialisation of variables
m= 10 //lb
cp= 0.180 //Btu/lb F
cp1= 0.235 //Btu/lb F
L= 15.8 //btu/lb
L1= 120 //btu/lb
T1= 70 //F
T2= 235 //F
T3= 832 //F
//CALCULATIONS
Qa= m*cp*(T2-T1)
Qb= m*L
Qc= m*cp1*(T3-T2)
Qd= m*L1
Q= Qa+Qb+Qc+Qd
//RESULTS
printf ('Heat required= %.f Btu',Q)
```

Scilab code Exa 3.4 chapter 3 example 4

```
clc
//initialisation of variables
m= 40 //lb
m1= 10 //lb
cp= 1.00 //Btu/lb F
cp1= 0.501 //Btu/lb F
cp2= 0.092 //Btu/lb F
L= 143.3 //btu/lb
L1= 120 //btu/lb
T1= 22 //F
T2= 32 //F
T3= 40 //F
T4= 70 //F
//CALCULATIONS
Qa= cp1*(T2-T1)
Qb= L
Qc= cp*(T3-T2)
Qd= m*cp*(T3-T4)
mi= -Qd/(Qa+Qb+Qc)
Qe= m1*cp2*(T3-T4)
mi1= -Qe/(Qa+Qb+Qc)
//RESULTS
printf ('Ice weight= %.2f lb of ice',mi)
printf (' \n Additional ice required= %.3f lb of ice
    ',mi1)
```

Chapter 5

First Law of Thermodynamics

Scilab code Exa 5.1 Chapter 5 example 1

```
clc
//initialisation of variables
p= 15 //psia
V2= 5 //cu
V1= 10 //cu
E= 34.7 //Btu
//CALCULATIONS
dE= -E-((p*(V2-V1)*144)/(778))
//RESULTS
printf ('Change in internal enenrgy of the gas= %.2f
    Btu',dE)
```

Scilab code Exa 5.2 chapter 5 example 2

```
clc
//initialisation of variables
m= 2 //lb
T2= 35 //F
```

```
cv= 1.2 //Btu/lb F
Q= 34 //Btu
//CALCULATIONS
U= m*cv*T2
W= Q-U
//RESULTS
printf ('Change in internal enenrgy = %.f Btu',W)
```

Scilab code Exa 5.3 chapter 5 example 3

```
clc
//initialisation of variables
p= 500 //psia
V2= 0.9278 //cu ft/lb
V1= 0.0197 //cu ft/lb
h= 1204.4 //Btu/lb
h1= 449.4 //Btu/lb
//CALCULATIONS
W= p*144*(V2-V1)
U= h-h1-(W/778)
//RESULTS
printf ('Change in internal enenrgy = %.1f Btu',U)
```

Scilab code Exa 5.4 chapter 5 example 4

```
clc
//initialisation of variables
m= 3 //lb
V1= 6 //cu ft
p1= 75. //psia
p2= 15 //psia
n= 1.2
Q1= 30 //Btu
```

```
//CALCULATIONS
V2= V1*(p1/p2)^(1/n)
disp(V2)
U= (m/3)*(0.480*p2*V2+35-0.480*p1*V1-35)
W= (p2*V2-p1*V1)/(1-n)
Q= U+W
W1= Q1-U
//RESULTS
printf ('Change in internal enenrgy = %.1f Btu',U)
printf (' \n Work done = %.f Btu',W)
printf (' \n Heat generated = %.f Btu',Q)
printf (' \n Work done = %.f Btu',W1)
//The answers given in the textbook are wrong.please
    calculate them personally.
```

Chapter 6

Flow Procesess First law analysis

Scilab code Exa 6.1 Chapter 6 example 1

```
clc
//initialisation of variables
u1= 1111.9 //Btu/lb
p= 170 //psia
v1= 2.675 //cu ft/lb
V1= 6000 //ft/min
g0= 32.2 //ft/sec^2
g= 32.2 //ft/sec^2
z= 10 //ft
Q= 1000//Btu/hr
u2= 914.6 //Btu/lb
p1= 3 //psia
v2= 100.9 //cu ft/lb
V2= 300 //ft/sec
g0= 32.2 //ft/sec^2
g= 32.2 //ft/sec^2
z1= 0 //ft
//CALCULATIONS
Wx= (u1+(p*v1*144/778)+((V1/60)^2/(2*g*778))+(z/778)
```

```
   -(Q/2500)-u2-(p1*v2*144/778)-((V2^2)/(2*g*778)))
   *2500
//RESULTS
printf ('Poweroutput = %.f hp',Wx*0.000393014779)
//It is the conversion factor from btu/hr to hp
```

Scilab code Exa 6.2 chapter 6 example 2

```
clc
//initialisation of variables
w1= 500 //lb/min
h1= 132.9 //Btu/lb
h2= 1150 //Btu/lb
h3= 180 //Btu/lb
//CALCULATIONS
w2= w1*(h3-h1)*60/(h2-h3)
//RESULTS
printf ('Steam supplied to the hater = %.f lb/hr',w2
   )
```

Scilab code Exa 6.3 chapter 6 example 3

```
clc
//initialisation of variables
h1= 1227.6 //Btu/lb
h2= 1223.9 //Btu/lb
g= 32.2 //ft/sec^2
v1= 4.937 //cu ft/lb
d= 2/12 //in
A1=%pi*d^2 /4.
//CALCULATIONS
V1= sqrt((2*g*(h1-h2)*778)/((1.1)^2-1))
V2= 1.1*V1
```

```
w=A1*V1/v1
//RESULTS
printf ('Average velovity at section1 = %.f fps',V1)
printf (' \n Average velovity at section2 = %.f fps'
    ,V2)
printf ('\n rate of flow =%.2f lb/sec', w)
```

Chapter 8

Basic applications of the second law

Scilab code Exa 8.1 Chapter 8 example 1

```
clc
//initialisation of variables
T1= 85 //F
T2= 50 //F
//CALCULATIONS
n= (T1-T2)/(T1+460)
n1= n*100
//RESULTS
printf ('Maximum thermal efficiency  = %.1f percent'
   ,n1)
```

Scilab code Exa 8.2 chapter 8 example 2

```
clc
//initialisation of variables
T1= 1050 //F
```

```
T2= 90 //F
//CALCULATIONS
n= (T1-T2)/(T1+460)
n1= n*100
//RESULTS
printf ('Maximum thermal efficiency  = %.f percent',
   n1)
```

Scilab code Exa 8.3 chapter 8 example 3

```
clc
//initialisation of variables
m= 1 //lb
cp= 0.240 //btu/lb F
T2= 150 //F
T1= 50 //F
//CALCULATIONS
S= m*cp*(log(460+T2)-log(460+T1))
//RESULTS
printf ('Entropy change = %.4f Btu/Fabs',S)
```

Scilab code Exa 8.4 chapter 8 example 4

```
clc
//initialisation of variables
m= 1 //lb
cp= 0.240 //btu/lb F
T2= 150 //F
T1= 50 //F
//CALCULATIONS
S= m*cp*(log(460+T2)-log(460+T1))
//RESULTS
printf ('Entropy change = %.4f Btu/Fabs',S)
```

```
//This result is same as the above since change in
    entropy does not depend on the process involved
// but only on the initial and final states
```

Scilab code Exa 8.5 chapter 8 example 5

```
clc
//initialisation of variables
Q= 826 //Btu/lb
T= 400 //F
T1= 1000 //F
T2= 2000 //F
//CALCULATIONS
Sw= Q/(T+460)
Sg= (Q/T1)*(log(T1+460)-log(T2+460))
S= Sw+Sg
//RESULTS
printf ('Total Entropy change = %.3f Btu/R',S)
```

Scilab code Exa 8.6 chapter 8 example 6

```
clc
//initialisation of variables
Q= 826 //Btu/lb
T= 400 //F
T1= 1000 //F
T2= 2000 //F
T3= 80 //F
//CALCULATIONS
Sw= Q/(T+460)
Sg= (Q/T1)*(log(T1+460)-log(T2+460))
S= Sw+Sg
Q1= (T3+460)*S
```

```
Q2= Q+(T3+460)*Sg
n= Q1/Q2
n1= n*100
//RESULTS
printf ('Loss percent = %d ',n1+1)
```

Chapter 10

Tabulated properties Steam Tables

Scilab code Exa 10.1 Chapter 10 example 1

```
clc
//initialisation of variables
p= 100//psia
vg= 4.432 //cu ft/lb
vf= 0.01744 //cu ft/lb
T= 327.8 //F
sfg= 1.1286 //Bu/lb R
//CALCULATIONS
Q=(T+460)*sfg
//RESULTS
printf ('Heat of vaourisation= %.f Btu/lb',Q)
```

Scilab code Exa 10.2 chapter 10 example 2

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

```
S= 1.6315 //Btu/lb R
//CALCULATIONS
P= 70 //psia
t= 302.92 //F
h= 1180.6 //Btu/lb
//RESULTS
printf ('Pressure= %.2f Psia',P)
printf (' \n Temperature = %.2f F',t)
printf (' \n Enthalpy= %.1f Btu/lb',h)
```

Scilab code Exa 10.3 chapter 10 example 3

```
clc
//initialisation of variables
T= 250 //F
hg= 1164.0 //Btu/lb
P= 29.825 //Psia
Vg= 13.821 //cu ft/lb
//CALCULATIONS
ug= hg-(P*Vg*144/778)
//RESULTS
printf ('Internal energy= %.1f Btu/lb',ug)
```

Scilab code Exa 10.4 chapter 10 example 4

```
clc
//initialisation of variables
P= 100 //psia
n= 40
vf= 0.01774 //cu ft/lb
vg= 4.432 //cu ft/lb
hf= 298.4 //Btu/lb
hfg= 888.8 //Btu/lb
```

```
sg= 1.6026 //Btu/lb R
sfg= 1.1286 //Btu/lb R
//CALCULATIONS
vx= (n/100)*vf+(1-(n/100))*vg
hx= hf+(1-(n/100))*hfg
sx= sg-(n/100)*sfg
//RESULTS
printf ('Volume= %.2f cu ft/lb',vx)
printf (' \n Entropy = %.2f Btu/lb R',sx)
printf (' \n Enthalpy= %.1f Btu/lb',hx)
```

Scilab code Exa 10.5 chapter 10 example 5

```
clc
//initialisation of variables
P= 100 //psia
n= 0.97
hf= 298.4 //Btu/lb
hfg= 888.8 //Btu/lb
hg= 1187.2 //Btu/lb
//CALCULATIONS
hx= hf+n*hfg
hx1= hg-(1-n)*hfg
//RESULTS
printf ('Enthalpy= %.f Btu/lb',hx)
printf (' \n Precise Enthalpy= %.1f Btu/lb',hx1)
```

Scilab code Exa 10.6 chapter 10 example 6

```
 clc
//initialisation of variables
P= 15 //psia
S= 1.7050 //Btu/lb R
```

```
sg= 1.7549 //btu/lb R
sfg= 1.4415 //Bru/lb R
hg= 1150.8 //btu/lb
hfg= 969.7 //Btu/lb
vg= 26.29 //cu ft/lb
vfg= 26.27 //cu ft/lb
//CALCULATIONS
n= (sg-sx)/sfg
sx= sg-n*sfg
hx= hg-n*hfg
vx= vg-n*vfg
//RESULTS
printf ('Volume= %.2f cu ft/lb',vx)
printf (' \n Entropy = %.2f Btu/lb R',sx)
printf (' \n Enthalpy= %.1f Btu/lb',hx)
```

Scilab code Exa 10.10 chapter 10 example 10

```
 clc
//initialisation of variables
T= 100 //F
P= 1000 //psia
dv= -5.1*10^-5 //cu ft/lb
dh= 2.70 //Btu/lb
vf= 0.01613 //cu ft/lb
hf= 67.97 //Btu/lb
//CALCULATIONS
h= dh+hf
v= dv+vf
//RESULTS
printf ('Volume= %.5f cu ft/lb',v)
printf (' \n Enthalpy= %.2f Btu/lb',h)
```

Scilab code Exa 10.11 chapter 10 example 11

```
clc
//initialisation of variables
h1= 1183.2 //Btu/lb
hg= 1198.4 //Btu/lb
hfg= 843.0 //Btu/lb
//CALCULATIONS
n= 1-((hg-h1)/hfg)
//RESULTS
printf ('quality= %.3f ',n)
```

Chapter 11

Properties of Gases

Scilab code Exa 11.1 Chapter 11 example 1

```
clc
//initialisation of variables
P= 15 //psia
T= 80 //F
m= 3 //lb
P1= 25 //psia
T1= 75 //F
//CALCULATIONS
r= (P*(460+T1))/(P1*(T+460))
m2= m/(1-r)
V2= (m2*55.16*(460+T1))/(P1*144)
//RESULTS
printf ('Volume of the apparatus= %.1f cu ft',V2)
```

Scilab code Exa 11.2 chapter 11 example 2

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

```
R= 48.3 //ft lb/lb R
T= 100 //F
T1= 500 //F
T2= 1500 //F
k= 1.4
k1= 1.36
k2= 1.31
//CALCULATIONS
dc= R/778
cp= (k/(k-1))*dc
cv= cp/k
cp1= (k1/(k1-1))*dc
cv1= cp/k1
cp2= (k2/(k2-1))*dc
cv2= cp2/k2
//RESULTS
printf ('cp= %.3f Btu/lb R',cp)
printf (' \n cv= %.3f Btu/lb R',cv)
printf (' \n cp1= %.3f Btu/lb R',cp1)
printf (' \n cv1= %.3f Btu/lb R',cv1)
printf (' \n cp2= %.3f Btu/lb R',cp2)
printf (' \n cv2= %.3f Btu/lb R',cv2)
```

Scilab code Exa 11.4 chapter 11 example 4

```
clc
//initialisation of variables
P= 10 //psia
P1= 100 //psia
T= 140 //F
k= 1.4
R= 55.16 //ft lb/lb R
//CALCULATIONS
dh= (k*R*(T+460)/(k-1))*((P/P1)^((k-1)/k)-1)
   *(72/56000)
```

```
//RESULTS
printf ('Enthalpy change= %.1f Btu/lb',dh)
```

Scilab code Exa 11.5 chapter 11 example 5

```
clc
//initialisation of variables
P= 100 //psia
P1= 15 //psia
T= 2000 //F
k= 1.4
R= 53.34 //ft lb/lb R
cp= 0.240 //Btu/lb R
//CALCULATIONS
v1= (R*(T+460)/(P*144))*(P/P1)^(1/k)
disp(v1)
T1= (T+460)*(P1*v1/(P*(R*(T+460)/(P*144))))
dh= cp*(T1-T)
dv= v1-(R*(T+460)/(P*144))
disp('case 1')
printf ('change in volume = %.2f', dv)
disp('case 2')
T2=1500 //F
v2=R*(T+460)/(P*144)/0.241
disp(v2)
T2=(T2+460)*(P1*v2/(P*(R*(T2+460)/(P*144))))
deltah=0.276*(T2-460-T)
dv2=v2-(R*(T+460)/(P*144))
printf ('change in volume = %.2f cu ft/lb', dv2)
disp('At T1=2460 R, from table 1, case 3')
h1=634.34
pr1=407.3
pr2=pr1*P1/P
T2=1075 //F
h2=378.44
```

```
deltah=h2-h1
v2=53.34*(T2+460)/(P1*144)
disp(v2)
dv3=v2-(R*(T+460)/(P*144))
printf ('change in volume = %.2f cu ft/lb',dv3)
```

Chapter 12

Properties of Gaseous Mixtures

Scilab code Exa 12.1 Chapter 12 example 1

```
clc
//initialisation of variables
P= 15.0 //psia
T= 55 //F
P1= 0.2141 //psia
ma= 29 //lb
mb= 18 //lb
P2= 0.2141 //psia
P3= 0.3631 //psia
//CALCULATIONS
dp= P-P1
r= (dp*ma)/(P1*mb)
r1= r/(r+1)
r2= 1/(r+1)
r4= r2/r1
P= P2/P3
//RESULTS
printf ('relative humidity= %.2f ',P)
printf (' \n specific humidity= %.4f lb vapour/lb
   air',r4)
```

Scilab code Exa 12.2 chapter 12 example 2

```
clc
//initialisation of variables
h= 29.5 //in
n= 75
T= 80 //F
h1= 10 //in
mw= 0.380*18
ma= 14.47*29
d= 13.6 //kg/m^3
P= 0.5069 //psi
//CALCULATIONS
Pw= (n/100)*P
P= (h+(h1/d))*(0.491)
pa= P-Pw
r= mw/ma
//RESULTS
printf ('Pounds of water vapour enter the furnance
   per pound of dry air= %.4f lb vapour/lb air',r)
```

Scilab code Exa 12.3 chapter 12 example 3

```
clc
//initialisation of variables
n= 0.5
T= 75 //F
P= 14.7 //psia
pg= 0.4298 //psia
pw= 0.2149 //psia
//CALCULATIONS
pw1= n*pg
```

```
pa= P-pw1
r= 0.622*pw/pa
//RESULTS
printf ('relative humidity= %.5f lb water/lb dry air
    ',r)
```

Scilab code Exa 12.4 chapter 12 example 4

```
clc
//initialisation of variables
r2= 0.0078 //lb water /lb dry air
r1= 0.0032 //lb water /lb dry air
h2= 25.33 //Btu/lb
h1= 12.9 //Btu/lb
pg= 0.1217 //psia
p= 14.7 //psia
h3= 13 //Btu/lb
n= 60
t2=70
t1=40
cpa=0.240
R2= 0.00788 //lb/lb of dry sir
w1= 0.00477 //lb/lb of dry sir
//CALCULATIONS
disp('Method 1')
w= r2-r1
q= h2-h1-w*h3
printf ('In method 1, Enthalpy =%.2f Btu/lb of dry
    air',q)
disp('Method 2')
R1= 0.622*(n/100)*(pg/(p-pg))
R2=0.00788
w2=R2-R1
//All constants are obtained from steam tables
Q=cpa*(t2-t1)+R2*(1092.6)-R1*(1079.6) -w2*h3
```

```
printf ('In method 2, Enthalpy = %.2f btu/lb of dry
    air',Q)
```

Scilab code Exa 12.5 chapter 12 example 5

```
clc
//initialisation of variables
P= 1//atm
n= 70
T= 75 //F
T1= 70 //F
r1= 0.0131 //lb water/lb dry air
r2= 0.0093 //lb water/lb dry air
h1= 32.36 //Btu/lb dry air
h2= 27.03 //Btu/lb dry air
hd2= 23.40 //Btu/lb dry air
hf= 23.4 //Btu/lb dry liquid
hg= 1094.5 //Btu/lb dry liquid
//CALCULATIONS
R1= r1-r2
Qc= hd2-h1+R1*hf
Qh= h2-hd2
x= R1*(hg-hf)
y= x/(-Qc)
//RESULTS
printf ('Fraction of heat removed in the coil= %.2f
    ',y)
```

Chapter 13

Vapor cycles

Scilab code Exa 13.1 Chapter 13 example 1

```
clc
//initialisation of variables
P= 1 //psia
P1= 200 //psia
T= 750 //F
v3= 0.01614 //cu ft/lb
h1= 1399.2 //Bu/lb
h2= 976 //Btu/lb
h3= 69.7 //Btu/lb
//CALCULATIONS
dh= v3*(144/778)*(P1-P)
h4= h3+dh
Q1= h1-h4
Wt= h1-h2
Wp= h4-h3
n= (Wt-Wp)/Q1
w= 2545/Wt
//RESULTS
printf ('cycle efficency = %.3f ',n)
printf (' \n steam rate= %.2f lb steam per hphr',w)
```

Scilab code Exa 13.2 chapter 13 example 2

```
clc
//initialisation of variables
wt= 8 //lb/hphr
h1= 1399.2 //Btu/lb
h2s= 976 //Btu/lb
h2= 976 //Btu/lb
//CACLAULATIONS
Wt= 2545/wt
nt= Wt/(h1-h2s)
h21= h1-Wt
//RESULTS
printf ('Engine efficency = %.3f ',nt)
printf (' \n state  of the exhaust steam= %.3f Btu/lb',h21)
```

Scilab code Exa 13.3 chapter 13 example 3

```
clc
//initialisation of variables
h1=1474.5 //btu/lb
s1=1.5603 //btu/lb R
h2s=1277.5 //btu/lb
//Calculations and printfing
h2=h1-0.85*(h1-h2s)
printf ('h2= %.2f Btu/lb',h2)
h3=1522.4  //btu/lb
s3=1.7623 //btu/lb R
h4s=948 //btu/lb
h4=h3- 0.85*(h3-h4s)
printf ('\n h4= %.2f Btu/lb',h4)
```

```
h5=47.6 //btu/lb
h6=53.5 //btu/lb
disp('For the first rankine cycle')
h7s=840 //btu/lb
h7=h1-0.85*(h1-h7s)
printf ('h7= %.2f Btu/lb',h7)
disp('For the second rankine cycle')
h8=1493.2 //btu/lb
s8=1.6903 //btu/lb R
h9s=866 //btu/lb
h9=h8-0.85*(h8-h9s)
printf ('h9= %.2f Btu/lb',h9)
h11=51.5 //btu/lb
n1=0.401
n2=0.375
n3=0.366
e1=(n1-n2)/n2
printf ('\n Percentage Efficiency of reheat cycle
   compared to Rankine cycle for the first case = %
   .2f',e1*100)
e2=(n1-n3)/n3
printf ('\n Percentage Efficiency of reheat cycle
   compared to Rankine cycle for the second case = %
   .2f',e2*100)
```

Scilab code Exa 13.4 chapter 13 example 4

```
clc
//initialisation of variables
h1= 1371 //Btu/lb
h2s= 1149 //Btu/lb
h3= 118 //Btu/lb
Q1= 1253 //Btu/lb
W= 156 //Btu/lb
Qw= 680 //Btu/lb
```

```
//CALCULATIONS
Qh= h1-W-h3
y= W+0.9*Qh
r= y/Q1
x= Qh+Qw
z= y/x
//RESULTS
printf ('Fraction of energy supplied = %.2f ',r)
printf (' \n Fraction of energy supplied= %.2f ',z)
```

Chapter 14

Combustion Processes First law analysis

Scilab code Exa 14.1 Chapter 14 example 1

```
clc
//initialisation of variables
M= 114 //lb
Mo= 32 //lb
Mn= 28 //lb
Mc= 44 //lb
Mw= 18 //lb
//CALCULATIONS
Ma= (12.5*Mo+(12.5)*(79/21)*Mn)/114
//RESULTS
printf ('Theoritical air for combustion= %.1f lb air
    per lb C8H18 ',Ma)
```

Scilab code Exa 14.4 chapter 14 example 4

```
clc
```

```
//initialisation of variables
mO2=1.33 //lb
mCO2=3.67 //lb
CvO2=0.155 //Btu/lb F
CvCO2=0.165 //Btu/lb F
Cc=0.170 //Btu/lb F
t2=1000 //F
tB=68 //F
t=300 //F
mC=1
mO=4
//Calculations
deltaE1=mO2*CvO2*(t2-tB) + mCO2*CvCO2*(t2-tB)
deltaE2=mC*CC*(tB-t) + mO*CvO2*(tB-t)
E= -14087 //Btu
Q=deltaE1+E+deltaE2
//Results
printf ('Heat Transfer from the system = %.2f',Q)
```

Scilab code Exa 14.5 chapter 14 example 5

```
clc
//initialisation of variables
HV=4344 //Btu/lb
m=56 //lb
R=1.986 //Btu/lb mol R
Tb=530 //R
//Calculations
HR=m*HV
Eb=-HR-R*Tb*(2-3)
printf ('Constant pressure heating value = %.1f Btu/
   lb formula wt',Eb)
```

Scilab code Exa 14.6 chapter 14 example 6

```
clc
//initialisation of variables
mC=1 //lb
mO2=2.67 //lb
mN2=8.78 //lb
mCO2=3.67 //lb
mN2=8.78 //lb
tB=77 //F
deltaH=14087 //Btu/lb
CpCO2=0.196 //Btu/lb F
CpCO2f=0.3 //Btu/lb F
CpN2=0.248 //Btu/lb F
CpN2f=0.285 //Btu/lb F
//Calculations
t2= tB+ deltaH/(mCO2*CpCO2 + mN2*CpN2)
t2f=tB+ deltaH/(mCO2*CpCO2f + mN2*CpN2f)
//Results
printf ('In case 1, t2 = %.1f F',t2)
printf ('\n In case 2, t2f = %.1f F',t2f)
```

Scilab code Exa 14.7 chapter 14 example 7

```
clc
//initialisation of variables
HR=14087 //Btu
HRC=3952 //Btu
x1=0.9
x2=0.05
//Calculations
HR1=x1*HR
HR2=x2*HRC
e=(HR2+HR1)/HR
//Results
```

```
printf ('Efficiency = %.3f',e)
```

Scilab code Exa 14.8 chapter 14 example 8

```
clc
//initialisation of variables
h= 19500 //Btu
w= 700 //lb/hr
Q= 10240000
//CALCULATIONS
Q1= w*h
e= Q/Q1
//RESULTS
printf ('Efficiency= %.2f ',e)
```

Chapter 15

Gas cycles

Scilab code Exa 15.1 Chapter 15 example 1

```
clc
//initialisation of variables
p= 15 //psia
p1= 75 //psia
T= 550 //R
T1= 1700 //R
k= 1.4
//CALCULATIONS
Ta= T*(p1/p)^((k-1)/k)
Tc= T1/((p1/p)^((k-1)/k))
cp= 0.24
Q1= cp*(T1-Ta)
Q2= cp*(Tc-T)
Wnet= Q1-Q2
n= Wnet/Q1
hb= 422.59 //Btu/lb
hc= 269.27 //Btu/lb
ha= 208.41 //Btu/lb
hd= 131.46 //btu/lb
Q1i= hb-ha
Q2i= hc-hd
```

```
Wnet1= Q1i-Q2i
n1= Wnet1/Q1i
//RESULTS
printf ('Efficiency = %.2f ',n)
printf ( 'Efficiency = %.3f ',n1)
```

Scilab code Exa 15.2 chapter 15 example 2

```
clc
//initialisation of variables
p= 15 //psia
p1= 75 //psia
T= 550 //R
T1= 1700 //R
k= 1.4
n= 75
cp= 0.24
//CALCULATIONS
Ta= T*(p1/p)^((k-1)/k)
Tc= T1/((p1/p)^((k-1)/k))
Ta1= (n/100)*(Tc-Ta)+Ta
Tc1= Ta+Tc-Ta1
Q1= cp*(T1-Ta1)
Q2= cp*(Tc1-T)
Wnet= Q1-Q2
n1= Wnet/Q1
//CALCULATIONS
printf ('Efficiency = %.2f ',n1)
```

Scilab code Exa 15.3 chapter 15 example 3

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

```
h1= 124.27 //Btu/lb
Pr1= 1.2147 //psia
r= 6
p4= 15 //psia
p1= 15 //psia
h2s= 197.5 //Btu/lb
Wnet= 48.9 //Btu/lb air
hs= 18500 //Btu/lb
wfbywa= 0.0146 //lb fuel/lb sir
W= 2545 //Btu/lb air
dh=-91.5 //Btu/lb
Wc= 91.5 //Btu/lb air
//CALCULATIONS
n= Wnet/(wfbywa*hs)
n1= W/Wnet
n2= Wc/Wnet
//RESULTS
printf ('Efficiency = %.3f ',n)
printf (' \n air rate= %.1f lb air/hphr',n1)
printf (' \n back work ratio= %.2f ',n2)
```

Chapter 16

Fluid Flow Nozzles and Turbines

Scilab code Exa 16.1 chapter 16 example 1

```
clc
//initialisation of variables
h1=1279.1 //Btu/lb
s1=1.7085 //Btu/lb R
p1= 100 //psia
p2=10 //psia
h2=1091.7 //Btu/lb
s2=s1
V1=100 //fps
v2=36.41 //cu ft/lb
w=1 //lb/sec
//Calculations
a2=w*v2/(sqrt(V1*V1 + 2*24956.243*(h1-h2)))
printf ('Exit area = %.5f sq. ft',a2)
pt=0.55*p1
ht=1221.5 //Btu/lb
vt=8.841 //cu ft/lb
at=w*vt/(sqrt(V1*V1 + 2*24956.243*(h1-ht)))
printf ('\n Exit area in case 2 = %.5f sq. ft',at)
```

Scilab code Exa 16.2 chapter 16 example 2

```
clc
//initialisation of variables
w=10000 //lb/hr
p0=250 //psia
T1=500 //F
Pf=1 //psia
vc=0.949
dc=1
h0=1263.4 //btu/lb
s0=1.5949 //btu/lb R
v2=276 //cu ft/lb
//Calculations
pt=0.55*p0
disp('from tables')
hts=1208.2 //btu/lb
vts=3.415 //cu ft/lb
h2s=891. //btu/lb
Vts=sqrt(2*32.174*778*(h0-hts))
w=w/3600 //lb/sec
cw=1
at=w*vts/(cw*Vts)
printf ('Throat area = %.5f ft^2',at)
V2=sqrt(2*32.174*778*(h0-h2s))
eta=0.9
h2=h0-eta*(h0-h2s)
a2s=w*v2/(cw*V2)
printf ('\n Exit area = %.5f ft^2',a2s)
```

Scilab code Exa 16.3 chapter 16 example 3

```
clc
//initialisation of variables
k=1.4
ptbyp0=0.53
T0=800 //R
cp=778
R=0.0425864
P0=150 //psia
Pt=15 //psia
w=1 //lb/sec
cw=1.0043782
//Calculations
Pt2=ptbyp0*Pt
Tts=T0*(ptbyp0)^((k-1)/k)
Vts=sqrt(2*32.174*cp*0.24*(T0-Tts))
printf ('Exit velocity case 1= %.2f fps',Vts)
vts=3.12 //cu ft/lb
at=w*vts/(cw*Vts)
printf ('\n Throat Area = %.5f ft^2', at)
T2s=T0*(Pt/P0)^((k-1)/k)
eta=0.88
T2=T0-eta*(T0-T2s)
V2=sqrt(2*32.174*cp*0.24*(T0-T2))
printf ('\n Exit velocity = %.2f fps', V2)
v2=11.4 //cu ft/lb
a2=w*v2/V2
printf('\n Exit area = %.5f ft^2',a2)
```

Chapter 17

Gas compression

Scilab code Exa 17.1 chapter 17 example 1

```
clc
//initialisation of variables
R= 53.31
T= 80 //F
P2= 90//psia
P1= 15 //psia
n= 1.4
n1= 1.3
cv= 0.171
//CALCULATIONS
Wk= (n/(n-1))*R*(T+460)*((P2/P1)^((n-1)/n)-1)
Wn= (n1/(n1-1))*R*(T+460)*((P2/P1)^((n1-1)/n1)-1)
Wt= R*(T+460)*log(P2/P1)
Q= cv*0.778*((n-n1)/(1-n1))*(T+460)*((P2/P1)^((n-1)/
   n)-1)
//RESULTS
printf ('Heat transfered from the airin each case= %
   .1f Btu/lb',Q)
```

Scilab code Exa 17.2 chapter 17 example 2

```
clc
//initialisation of variables
R= 53.31
T= 80 //F
P2= 90//psia
P1= 15 //psia
n= 1.4
n1= 1.3
cv= 0.171
//CALCULATIONS
Wk= (n/(n-1))*R*(T+460)*((P2/P1)^((n-1)/n)-1)
Wn= (n1/(n1-1))*R*(T+460)*((P2/P1)^((n1-1)/n1)-1)
Wt= R*(T+460)*log(P2/P1)
nc= Wt/Wn
nc1=Wk/Wn
////RESULTS
printf ('Thermal effeciency= %.2f ',nc)
printf (' \n Isothermal effeciency= %.2f ',nc1)
```

Scilab code Exa 17.3 chapter 17 example 3

```
clc
//initialisation of variables
R= 53.31
T= 80 //F
P2= 90//psia
P1= 15 //psia
n= 1.4
cp= 0.240
nc= 0.95
n1= 1.3
//CALCULATIONS
Wk= (n/(n-1))*(R)*(T+460)*((P2/P1)^((n-1)/n)-1)
```

```
Wx= -Wk/nc
dh= cp*(T+460)*((P2/P1)^((n1-1)/n1)-1)
Q= dh+(Wx/778)
//RESULTS
printf ('Heat transferred= %.1f Btu/lb ',Q)
```

Scilab code Exa 17.4 chapter 17 example 4

```
clc
//initialisation of variables
P1= 83.5//psia
P2= 5 //psia
n= 3 //percent
n1= 1.25
//CALCULATIONS
nv= 1-(n/100)*((P1/P2)^(1/n1)-1)
nv1= 1-(n/100)*(sqrt((P1/P2)^(1/n1))-1)
//RESULTS
printf ('single-stage compression = %.3f ',nv)
printf (' \n two-stage compression = %.3f ',nv1)
```

Chapter 18

Refrigeration

Scilab code Exa 18.1 chapter 18 example 1

```
clc
//initialisation of variables
T2 = 0 //F
T1= 76  //F
h1= 611.8 //Btu/lb
h4= 127.4 //Btu/lb
h2= 704.4 //Btu/lb
x= 10000 //Btu/hr
v1= 9.116 //cu ft/lb
n=70
//CALCULATIONS
CP= (T2+460)/(T1-T2)
CP1= (h1-h4)/(h2-h1)
w= (x/60)/(h1-h4)
PD=(w*v1)/(n/100)
//RESULTS
printf ('CP1 = %.2f  ',CP)
printf (' \n CP2 = %.2f  ',CP1)
printf (' \n PD = %.2f cu ft/min',PD)
```

Chapter 19

Heat Transmission

Scilab code Exa 19.2 chapter 19 example 2

```
clc
//initialisation of variables
t= 8 //in
t1= 1 //in
k= 0.50 //Btu/hr ft F
k1= 0.02 //Btu/hr ft F
A= 1 //ft^2
T= 60 //F
T1= -20 //F
//CALCULATIONS
Rc= (t/12)/(k*A)
Rf= (t1/12)/(k1*A)
R= Rc+Rf
q= (T-T1)/R
T2= (T+(Rc/Rf)*T1)/(1+(Rc/Rf))
//RESULTS
printf ('Rate of heat flow= %.1f Btu/hr',q)
printf (' \n Temperature at the interface= %.1f F',
   T2)
```

Scilab code Exa 19.3 chapter 19 example 3

```
clc
//initialisation of variables
h1= 2500 //Btu/sq ft hr F
r= 10 //in
t= 0.375 //in
Ts= 500 //F
Ta= 80 //F
r2= 5.375 //in
r1= 5 //in
r3= 7.375 //in
kp= 26 //Btu ft/hr
ki= 0.045 //Btu ft/hr
h1= 2500 //Btu/sq ft hr F
h3= 1.6 //Btu/sq ft hr F
r4= 14.750
//CALCULATIONS
R1= 1/(h1*%pi*(r/12))
Rp= log(r2/r1)/(2*%pi*kp)
Ri= log(r3/r2)/(2*%pi*ki)
R3= 1/(h3*%pi*(r4/12))
R0= R1+Rp+Ri+R3
T3=Ta+ (Ts-Ta)*R3/R0
//RESULTS
printf ('Temperature at the interface= %.6f F',T3)
```

Scilab code Exa 19.4 chapter 19 example 4

```
clc
//initialisation of variables
wh= 40000 //lb.hr
```

```
cph= 0.5 //Btu/lb F
th1= 170 //F
th2= 120 //F
cpc= 1 //Btu/lb F
tc2= 140 //F
tc1= 100 //F
t= 140 //F
U= 120 //Btu/sq ft hr F
//CALCULATIONS
dh= t-th2
dc= tc2-tc1
wc= (wh*cph*(th1-th2))/(cpc*dc)
dtm= (-(tc1-th2)-(th1-tc2))/log((tc1-th2)/(-th1+tc2)
   )
q= wh*cph*(th1-th2)
A= q/(U*dtm)
th2= ((wh/wc)*(cph/cpc)*th1+tc1)/((wh/wc)*(cph/cpc)
   +1)
wc1= (wh*cph*(th1-th2))/(cpc*(th2-tc1))
//RESULTS
printf ('Water flow rate= %.f lb/hr',wc)
printf (' \n Area of heat transfer surface= %.f sq
   ft',A)
printf (' \n temperature of the oil= %.f F',th2)
printf (' \n flow rate= %.f lb/hr',wc1*2)
```

Scilab code Exa 19.5 chapter 19 example 5

```
clc
//initialisation of variables
Tw= 200 //F
Ta= 600 //F
V= 100 //fps
Di= 0.902 //in
d= 0.0375 //lb/cu ft
```

```
u= 0.000020 //lbm/sec
cp= 0.25 //Btu/lb F
k= 0.027 //Btu/sq ft hr
//CALCULATIONS
NRe= (Di*V*d)/(u*12)
Npr= 0.66
h= k*0.023*NRe^0.8*Npr^0.4*12/Di
//RESULTS
printf ('Film coefficient = %.1f Btu/sq ft hr F',h)
```

Scilab code Exa 19.6 chapter 19 example 6

```
clc
//initialisation of variables
Tw= 200 //F
Ta= 600 //F
cpb= 0.25 // Btu/lb F
tf= 0.68
uf= 0.000017 //lbm/sec ft
D= 0.902 //in
V= 100 //fps
d= 0.0375 //lb/cu ft
//CALCULATIONS
Nre= (D/12)*V*d/uf
Npr= 0.68
h= cpb*V*3600*d*0.023/(Nre^0.2*Npr^(2/3))
//RESULTS
printf ('Film coefficient = %.1f Btu/sq ft hr F',h)
```

Scilab code Exa 19.7 chapter 19 example 7

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

```
A1= 0.916 //ft^2
e1= 0.8
s= 0.173 //BTU s^-1 in^-2 R^-4
T= 200 //F
T1= 70 //F
D= 0.292
//CALCULATIONS
q= (A1/10^6)*e1*s*(((T+460)^4/100)-((T1+460)^4/100))
hr= q/(A1*(T-T1))
hc= 0.27*((T-T1)/D)^0.25
//RESULTS
printf ('Heat loss= %.2f Btu/hr',q)
printf (' \n hr= %.2f Btu/sq ft hr F',hr)
printf (' \n hc= %.2f Btu/sq ft hr F',hc)
```

Scilab code Exa 19.8 chapter 19 example 8

```
clc
//initialisation of variables
T= 120 //F
T1= 1500 //F
A= 64/144
F= 0.86
Fe= 1
s= 0.173 //BTU s^-1 in^-2 R^-4
//CALCULATIONS
q= (A/10^6)*F*Fe*s*(((T1+460)^4/100)-((T+460)^4/100)
    )
//RESULTS
printf ('Heat loss= %.f Btu/hr',q)
```