Scilab Textbook Companion for Elementary Heat Power by H. L. Solberg[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.

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Chapter 1

Matter and energy

Scilab code Exa 1.1 Example 1

```
clc
clear
//Initialization of variables
g=32.2 //ft/s^2
m=500 //lb
rate=10 //ft/s^2
//calculations
F1=m/g *rate
ms=m/g
F2=ms*rate
//results
printf("Force in case 1 = %.1f lbf",F1)
printf("\n Force in case 2 = %.1f lbf",F2)
```

Scilab code Exa 1.2 Example 2

```
clc
clear
```

```
//Initialization of variables
g=32.2 //ft/s^2
g2=32.0 //ft/s^2
rate=10 //ft/s^2
w1=500 //lbf
//calculations
fd1=w1*g2/g
F=fd1/g2 *rate
ms=w1/g
F2=ms*rate
//results
printf("Net weight of body in case 1 = %.1f lbf",F)
printf("\n Force in case 2 = %.1f lbf",F2)
```

Scilab code Exa 1.3 Example 3

```
clc
clear
//Initialization of variables
g=32.174 //ft/s^2
m=500 //lbm
rate=10 //ft/s^2
//calculations
F=1/g *m*rate
//results
printf("Force required = %.1f lbf",F)
```

Scilab code Exa 1.4 Example 4

```
clc
clear
//Initialization of variables
g1=32.174 //ft/s^2
```

```
gc=g1
g2=30 //ft/s^2
m=100 //lbm
//calculations
w1=g1/gc *m
w2=g2/gc *m
//results
printf("Weight in case 1 = %d lbf",w1)
printf("\n Weight in case 2 = %.1f lbf",w2)
```

Scilab code Exa 1.5 Example 5

```
clc
clear
//Initialization of variables
ge=32.174 //ft/s^2
gm=5.47 //ft/s^2
we=50 //lbm
//calculations
wm=we*gm/ge
//results
printf("In case a, it will weigh the same, weight =
    %d lbm",we)
printf("\n In case b, weight = %.1f lbf",wm)
```

Scilab code Exa 1.6 Example 6

```
clc
clear
//Initialization of variables
g=32.2 //ft/s^2
p1=100 //psig
p2=29.0 //in of Hg
```

```
//calculations
BP=p2*0.491
AP=BP+p1
//results
printf("Absolute pressure = %.2f psia",AP)
```

Scilab code Exa 1.7 Example 7

```
clc
clear
//Initialization of variables
g=32.2 //ft/s^2
Pb=29.5 //in of Hg
Pv=10 //in of Hg
//calculations
AP=(Pb-Pv)*0.491
//results
printf("Absoulte pressure = %.2f psia",AP)
```

Scilab code Exa 1.8 Example 8

```
clc
clear
//Initialization of variables
g=32.2 //ft/s^2
v1=1 //cu ft
p1=100 //psia
//calculations
v2=2*v1
W=144*p1*(v2-v1)
//results
printf("Work done = %d ft-lb",W)
```

Scilab code Exa 1.9 Example 9

```
clc
clear
//Initialization of variables
g=32.2 //ft/s^2
v1=1 //cu ft
p1= 100 //psia
p2=50 //psia
v2=3 //cu ft
//calculations
pa=(p1+p2)/2
W=pa*(v2-v1)*144
//results
printf("Work done = %d ft-lb",W)
```

Scilab code Exa 1.10 Example 10

```
clc
clear
//Initialization of variables
g=32.2 //ft/s^2
p1=100 //psia
p2=25 //psia
v2=2 //cu ft
//calculations
W=p1*144*v2 - p2*144*v2
//results
printf("Work done = %d ft-lb",W)
```

Scilab code Exa 1.11 Example 11

```
clc
clear
//Initialization of variables
g=32.2 //ft/s^2
n=100 //rpm
p1=100 //psia
p2=25 //psia
v2=2 //cu ft
//calculations
W=p1*144*v2 - p2*144*v2
Hp=W*n/33000
//results
printf("Horsepower developed = %.1f hp",Hp)
```

Scilab code Exa 1.12 Example 12

```
clc
clear
//Initialization of variables
P=50 //hp
m=30 //lb
E=19000 //Btu/lb
//calculations
eta= P*2545/(m*E) *100
//results
printf("Efficiency = %.1f percent",eta)
```

Chapter 2

Fuels and Combustion

Scilab code Exa 2.1 Example 1

```
clc
clear
//Initialization of variables
x1=0.135
x2=0.056
veca=[32.5 48.4 5.6 13.5]
B1=11788
//calculations
vecb=veca/(1-x1)
vecc=veca/(1-x1-x2)
B2=B1/(1-x1)
B3=B1/(1-x1-x2)
vecb(4)=0
vecc(3)=0
vecc(4)=0
//results
printf("In Moisture free case, ")
format('v',6);vecb
disp(vecb)
printf("In Moisture and Ash free case, ")
format('v',6);vecc
```

```
disp(vecc)
printf("Energy in Moisture free case  = %d Btu per
   lb",B2)
printf("\n Energy in Moisture and ash free case  =
   %d Btu per lb",B3)
```

Scilab code Exa 2.2 Example 2

```
clc
clear
//Initialization of variables
y1=13.5
x1=0.135
x2=0.056
veca=[66 1.5 1.1 5.6 5.9 19.9]
//calculations
vecb=[veca y1]
vecb(5) = vecb(5) - 1/9*y1
vecb(6) = vecb(6) - 8/9*y1
vecc=vecb/(1-x1)
vecd=vecb/(1-x1-x2)
vecd(4)=0
vecd(7)=0
vecc(7)=0
s1=sum(vecc)
s2=sum(vecd)
//results
printf("With moisture as a separate item, ")
format ('v',6);vecb
disp(vecb)
printf("In Moisture free case, ")
format('v',4);vecc
disp(vecc)
printf("In Moisture and Ash free case, ")
format('v',5);vecd
```

```
disp(vecd)
printf("Total Mositure free content = %.1f percent",
    s1)
printf("\n Total Mositure and ash free content = %.1
    f percent",s2)
```

Scilab code Exa 2.3 Example 3

```
clc
clear
//Initialization of variables
H=5.9
O=19.9
H2=4.4
O2=7.9
//calculations
Ha1=H-O/8
Ha2=H2-O2/8
//results
printf("Available hydrogen in case 1 = %.1f percent
    by weight",Ha1)
printf("\n Available hydrogen in case 1 = %.1f
    percent by weight",Ha2)
```

Scilab code Exa 2.4 Example 4

```
clc
clear
//Initialization of variables
H1=0.059
O1=0.199
H2=0.044
O2=0.079
```

```
C=0.66
S=0.011
//calculations
Qh1= 14600*C+62000*(H1-O1/8)+4050*S
Qh2=14600*C+62000*(H2-O2/8)+4050*S
//results
printf("Heating value in case 1 = %d Btu/lb ",Qh1)
printf("\n Heating value in case 2 = %d Btu/lb ",Qh2)
```

Scilab code Exa 2.5 Example 5

```
clc
clear
//Initialization of variables
H1=0.059
O1=0.199
C=0.66
S=0.011
//calculations
Qh1= 11.52*C+34.56*(H1-O1/8)+4.32*S
//results
printf("Theoretical air required = %.2f lb of air per lb of coal ",Qh1)
```

Scilab code Exa 2.6 Example 6

```
clc
clear
//Initialization of variables
mf=10000 //lb
mr=700 //lb
Cr=0.20
```

```
Cco2=14.1
Co2=5.1
Cco=0.1
Cf=0.66
//calculations
Cn2=100-(Cco2+Co2+Cco)
Ci=mf*Cf
Ca=mr*Cr
Cb=(Ci-Ca)/mf
Cb2=((mf*Cf)-mr*Cr)/(mf)
veca=[Cco2 Co2 Cco Cn2]
vecb=veca
vecb(1)=vecb(1) *44
vecb(2)=vecb(2) *32
vecb(3)=vecb(3) *28
vecb(4)=vecb(4) *28
sumvec=sum(vecb)
Lbc=Cco2*12 + Cco*12
Gc=sumvec/Lbc
Gf=Gc*Cb
//results
printf("Carbon in the dry products combustion = %.3f
    lb per lb of fuel",Cb)
printf("\n In case 2, Carbon in the dry products
    combustion = %.3f lb per lb of fuel",Cb2)
printf("\n Dry gaseous products of combstion per lb
    of coal = %.2f lb ",Gf)
```

Scilab code Exa 2.7 Example 7

```
clc
clear
//Initialization of variables
mf=10000 //lb
mr=700 //lb
```

```
Cr=0.20
Cco2=14.1
Co2=5.1
Cco=0.1
Cf=0.66
//calculations
Cn2=100-(Cco2+Co2+Cco)
Ci=mf*Cf
Ca=mr*Cr
Cb=(Ci-Ca)/mf
Cb2=((mf*Cf)-mr*Cr)/(mf)
veca=[Cco2 Co2 Cco Cn2]
vecb=veca
vecb(1)=vecb(1) *44
vecb(2)=vecb(2) *32
vecb(3)=vecb(3) *28
vecb(4)=vecb(4) *28
Cbb1=Cb*Cco*12/(Cco2*12 + Cco*12)
Cbb2= Cb*(veca(3) /(veca(3) + veca(1)))
//results
printf("In case 1, Carbon burned per lb of fuel = %
    .5f lb per lb of fuel",Cbb1)
printf("\n In case 2, Carbon burned per lb of fuel =
     %.5f lb per lb of fuel",Cbb2)
```

Scilab code Exa 2.8 Example 8

```
clc
clear
//Initialization of variables
H=4.4/100
M=13.5/100
H2=0.059
//calculations
pro=M+9*H
```

```
pro2=9*H2
//results
printf("In case 1, watervapor present in products =
   %.3f lb",pro)
printf("\n In case 2, watervapor present in products
    = %.3f lb",pro2)
```

Scilab code Exa 2.9 Example 9

```
clc
clear
//Initialization of variables
Gf=11.57 //lb per lb of fuel
H=4.4/100
M=13.5/100
mr=700
mf=10000
mc=1 //lb
//calculations
pro=M+9*H
mrf=mr/mf
Aa=Gf+pro+mrf-mc
//results
printf("Actual air supplied = %.2f lb of air
   supplied per lb of fuel",Aa)
```

Scilab code Exa 2.10 Example 10

```
clc
clear
//Initialization of variables
Gf=11.57 //lb per lb of fuel
H=4.4/100
```

```
M=13.5/100
mr=700
mf=10000
mc=1 //lb
//calculations
pro=M+9*H
mrf=mr/mf
Aa=Gf+pro+mrf-mc
At=8.83
ea=(Aa-At)/At *100
//results
printf("Excess air = %.1f percent",ea)
```

Scilab code Exa 2.11.a Example 11

```
clear
//Initialization of variables
Gf=11.57 //lb per lb of fuel
tg=500 //F
ta=70 //F
//calculations
Q1=0.24*Gf*(tg-ta)
//results
printf("Heat loss = %d Btu per lb of fuel",Q1)
```

Scilab code Exa 2.11.b Example 12

```
clc
clear
//Initialization of variables
Co=0.1
Co2=14.1
Cb=0.646
```

```
//calculations
Q2=Co/(Co+Co2) *Cb*10160
//results
printf("Heat loss = %d Btu per lb of fuel",Q2)
```

Scilab code Exa 2.11c Example 13

```
clc
clear
//Initialization of variables
mf=10000 //lb
mr=700 //lb
Cr=0.2
//calculations
Q3=mr*Cr/mf *14600
//results
printf("Heat loss = %d Btu per lb of fuel",Q3)
```

Scilab code Exa 2.11d Example 14

```
clc
clear
//Initialization of variables
M=0.135
tg=500 //F
ta=70 //F
//calculations
Q4=M*(1089+0.46*tg-ta)
//results
printf("Heat loss = %.1f Btu per lb of fuel",Q4)
```

Scilab code Exa 2.11e Example 15

```
clc
clear
//Initialization of variables
Per=0.044 //percentage
tg=500 //F
ta=70 //F
//calculations
Q5=9*Per*(1089+0.46*tg-ta)
//results
printf("Heat loss = %.1f Btu per lb of fuel",Q5)
```

Chapter 3

Internal Combustion Engines

Scilab code Exa 3.1 Example 1

```
clc
clear
//Initialization of variables
re=6
k=1.4
//calculations
nt=1-1/re^(k-1)
ntt=nt*100
//results
printf("Thermal efficiency = %.1f percent",ntt)
```

Scilab code Exa 3.2 Example 2

```
clc
clear
//Initialization of variables
d=3.25 //in
str=4 //in
```

```
v=6 //cu in
//calculations
Dp=d^2 *%pi*str/4
r=(Dp+v)/v
//results
printf("Compression ratio = %.2f",r)
```

Scilab code Exa 3.3 Example 3

```
clc
clear
//Initialization of variables
per=20
Dp=100
//calculations
r=Dp/per +1
//results
printf("Compression ratio = %d ",r)
```

Scilab code Exa 3.4 Example 4

```
clc
clear
//Initialization of variables
r=16
rc=4
k=1.4
//calculations
etat=1-1/r^(k-1) *((rc^k -1)/(k*(rc-1)))
eta=etat*100
//results
printf("Thermal efficiency = %.1f percent",eta)
```

```
disp("The answer is a bit different due to rounding
   off error in the textbook")
```

Scilab code Exa 3.5 Example 5

```
clc
clear
//Initialization of variables
F=200 //lb
area=1.65 //sq. in
len=3.5 //in
//calculations
ord=area/len
mep=ord*F
//results
printf("MEP of an engine = %.1f psi",mep)
```

Scilab code Exa 3.6 Example 6

```
clc
clear
//Initialization of variables
Pi=90 //psi
L=5/12 //ft
r=5 //in
x=1.5 //ft
rpm=1500 //rpm
//calculations
A=%pi*x*x
N=rpm*4/2
Ihp=Pi*L*A*N/33000
//results
printf("IHP of cylinder = %d",Ihp)
```

Scilab code Exa 3.7 Example 7

```
clc
clear
//Initialization of variables
r=4 //ft
n=300 //rpm
F=60 //lb
//calculations
Bhp=2*%pi*r*F*n/33000
//results
printf("Bhp of the engine = %.1f",Bhp)
```

Scilab code Exa 3.8 Example 8

```
clc
clear
//Initialization of variables
C=1/4000
F=125 //lb
n=3500 //rpm
//calculations
Bhp=F*n*C
//results
printf("Bhp developed by the engine = %.1f",Bhp)
```

Scilab code Exa 3.9 Example 9

```
clc
```

```
clear
//Initialization of variables
r=1.75 //ft
F1=72 //lb
F2=24 //lb
n=500 //rpm
m=1.8 //lb
mi=15 //min
Qh=20000 //Btu/lb
//calculations
Bhp=2*%pi*r*F1*n/33000
Fhp=2*%pi*r*F2*n/33000
Ihp=Bhp+Fhp
Fc=m*60/mi
Bsfc=Fc/Bhp
Isfc=Fc/Ihp
etam=Bhp/Ihp *100
etabt=Bhp*2545/(Fc*Qh)
etait=Ihp*2545/(Fc*Qh)
//results
printf("Thermal efficiency = %d percent",etam)
printf("\n Brake thermal effficiency = %.1f percent",etabt*100)
printf("\n Indicated thermal effficiency = %.1f percent",etait*100)
```

Scilab code Exa 3.10 Example 10

```
clc
clear
//Initialization of variables
bore=3 //in
str=4 //in
rpm=3000 //rpm
air=110 //cu ft per min
```

```
//calculations
pdv=bore*bore*%pi*str*2*bore/4
pde=pdv*rpm /2
req=air*1728
eff=req/pde *100
//results
printf("Volumetric efficiency = %.1f percent",eff)
```

Scilab code Exa 3.11 Example 11

```
clc
clear
//Initialization of variables
x1=11.5
x2=4.1
x3=0.4
x4=2.3
x5=0.2
x6=81.5
yc=0.842
yh=0.158
basis=1
bhp=100
burn=8.9 //gal/hr
sg=0.731
Qh=20750 //Btu/lbm
rate=66 //gpm
ex=1100 //F
air=70 //F
cp=0.254
h2=4330
h4=62000
h5=23700
//calculations
c1=x1*44
```

```
c2=x2*28
c3=x3*32
c4=x4*2
c5=x5*16
c6=x6*28
summ=c1+c2+c3+c4+c5+c6
carbon=x1*12 + x2*12+x5*12
hydrogen=x4*2+x5*4
lbdrygas=summ/carbon *yc
lbfuel=carbon/yc
lbH=lbfuel*yh
lbH2=lbH-hydrogen
lb3=lbH2*9
lbwater=lb3/lbfuel
lbair=lbdrygas+lbwater-basis
bsfc=burn*sg*8.33/bhp
fuelmin=bsfc*bhp/60
energy=2545/bsfc
per1=energy/Qh
Ec=rate*8.33*10
Eclb=Ec/fuelmin
per2=Eclb/Qh
dryloss=(ex-air)*cp*lbdrygas
per3=dryloss/Qh
hv2=h2*c2/lbfuel
hv4=h4*c4/lbfuel
hv5=h5*c5/lbfuel
hv=hv2+hv4+hv5
per4=hv/Qh
eh2=lbwater*(1066+0.5*ex-air)
per5=eh2/Qh
rad=1017
per6=rad/Qh
//results
printf("Air supplied per lb of fuel = %.1f lb air
   per lb fuel",lbair)
printf("\n Percentage of energy supplied utilized in
    Btu = %.2f percent",per1*100)
```

```
printf("\n Percentage of energy absorbed by coolant = %.2f percent",per2*100)
printf("\n Energy lost in sensible heat = %.2f percent",per3*100)
printf("\n Energy supplied in combustiles in exhaust = %.2f percent",per4*100)
printf("\n Energy supplied in water formed by combustion = %.2f percent",per5*100)
printf("\n Energy supplied unaccounted for = %.2f percent",per6*100)
```

Chapter 5

Steam Generation

Scilab code Exa 5.1 Example 1

```
clc
clear
//Initialization of variables
x=0.98
vg=26.80
vf=0.01672
//calculations
vx=x*vg+(1-x)*vf
//results
printf("Specific volume of wet steam = %.6f cu ft
   per lb",vx)
```

Scilab code Exa 5.2 Example 2

```
clc
clear
//Initialization of variables
hf=167.99 //Btu/lb
```

```
hg=4.5 //Btu/lb
//calculations
hc=hf+hg
//results
printf("Enthalpy of water = %.1f Btu/lb",hc)
```

Scilab code Exa 5.3 Example 3

```
clc
clear
//Initialization of variables
x=0.97
hg=1187.2 //Btu/lb
hf=298.40 //Btu/lb
hfg=888.8 //Btu/lb
//calculations
hx1=x*hg+(1-x)*hf
hx2=hf+x*hfg
hx3=hg-(1-x)*hfg
//results
printf("\n In case 1, enthalpy = %.1f Btu/lb",hx1)
printf("\n In case 2, enthalpy = %.1f Btu/lb",hx2)
printf("\n In case 3, enthalpy = %.1f Btu/lb",hx3)
```

Scilab code Exa 5.4 Example 4

```
clc
clear
//Initialization of variables
h1=1172 //Btu/lb
hf1=355.36 //Btu/lb
hfg1=843 //Btu/lb
//calculations
```

```
h2=h1
x1= (h2-hf1)/hfg1
//results
printf("Quality of steam = %.1f percent",x1*100)
```

Scilab code Exa 5.5 Example 5

```
clc
clear
//Initialization of variables
P=200 //psia
x=0.95
m=1//lb
//calculations
disp("From mollier chart,")
hx=1156 //Btu/lb
sx=1.495 //Btu/lb F
//results
printf("Enthalpy = %d Btu/lb",hx)
printf("\n entropy = %.3f Btu/lb F",sx)
```

Scilab code Exa 5.6 Example 6

```
clc
clear
//Initialization of variables
P=200 //psia
T=600 //F
m=1 //lb
//calculations
disp("From mollier chart,")
hx=1322 //Btu/lb
sx=1.676 //Btu/lb F
```

```
//results
printf("Enthalpy = %d Btu/lb",hx)
printf("\n entropy = %.3f Btu/lb F",sx)
```

Scilab code Exa 5.7 Example 7

```
clc
clear
//Initialization of variables
P=200 //psia
T=260 //F
//calculations
disp("From mollier chart,")
hx=1174 //Btu/lb
x1=2.8
y1=100-x1
//results
printf("Quality = %.1f percent",y1)
```

Scilab code Exa 5.8 Example 8

```
clc
clear
//Initialization of variables
P=200 //psia
T=500 //F
//calculations
disp("From mollier chart,")
hi=1269 //Btu/lb
hf=1063 //Btu/lb
dh=hi-hf
y1=91
//results
```

```
printf("Quality = %.1f percent",y1)
printf("\n Change in enthalpy = %d Btu/lb",dh)
```

Scilab code Exa 5.9 Example 9

```
clc
clear
//Initialization of variables
P=200 //psia
Ts=260 //F
Tf=220 //F
m=10000 //lb
Pc=20 //psia
//calculations
disp("From mollier charts,")
hf=188 //Btu/lb
h2=1172 //Btu/lb
Q=m*(h2-hf)
//results
printf("Heat absorption = %d Btu/hr",Q)
```

Scilab code Exa 5.10 Example 10

```
clc
clear
//Initialization of variables
m=150000 //lb
P1=1000 //psia
Ts=900 //F
Tf=200 //F
//calculations
disp("From mollier charts,")
h2=1448.2 //Btu/lb
```

```
hf=167.99 //Btu/lb
correc=2.2 //Btu/lb
hc=hf+correc
Q=m*(h2-hc)
//results
printf("Heat absorption = %d Btu/hr",Q)
disp("The answer is a bit different due to rounding
    off error in textbook")
```

Scilab code Exa 5.11 Example 11

```
clc
clear
//Initialization of variables
m=150000 //lb
P1=1000 //psia
Ts=900 //F
Tf=200 //F
//calculations
disp("From mollier charts,")
h2=1448.2 //Btu/lb
hf=167.99 //Btu/lb
correc=2.2 //Btu/lb
hc=hf+correc
Q=m*(h2-hc)
output=Q/1000
//results
printf("Output of the steam generating unit = %d kB/
    hr",output)
```

Scilab code Exa 5.12 Example 12

```
clc
```

```
clear
//Initialization of variables
m=150000 //lb
P1=1000 //psia
Ts=900 //F
Tf=200 //F
m2=21000 //lb
HV=12000 //Btu/lb
//calculations
disp("From mollier charts,")
h2=1448.2 //Btu/lb
hf=167.99 //Btu/lb
correc=2.2 //Btu/lb
hc=hf+correc
Q=m*(h2-hc)
output=Q
inpu=m2*HV
eta=output/inpu
//results
printf("Efficiency of the steam generating unit = %.1f percent",eta*100)
```

Scilab code Exa 5.13 Example 13

```
clc
clear
//Initialization of variables
hv=11780 //Btu/lb
steam=55000 //lb/hr
coal=6480 //lb
x1=0.66
x2=0.044
x3=0.079
x4=0.015
x5=0.11
```

```
z1=14.5
z2=0.2
z3=4.4
z4=80.9
xash=0.076
xmois=0.115
yc=0.21
refuse=622 //lb/hr
cp=0.24
tg=400 //F
ta=70 //F
Qco=10160 //Btu/lb
Qc=14600 //Btu/lb
//calculations
disp("From steam tables,")
hf=269.6 //Btu/lbm
hfg=1.5 //Btu/lbm
h1=hf+hfg
h2=1196.5
Qb=h2-h1
h3=1407.7 //Btu/lbm
Qs=h3-h2
h4=h3-h1
out=steam*h4/1000
eff=steam*h4/(coal*hv)
//Energy balance
Ci=coal*x1
Cr=refuse*yc
Cb=(Ci-Cr)/coal
lbt= z1*44+z2*28+z3*32+z4*28
lbC=z1*12+z2*12
dry=lbt/lbC *Cb
loss1=dry*cp*(tg-ta)
loss2=z2*12/(lbC) *Cb*Qco
loss3=Cr*Qc/coal
loss4=xmois*(1089+0.46*tg-ta)
loss5=x2*9*(1089+0.46*tg-ta)
loss6=steam*h4/coal
```

```
//results
printf("Heat absorbed in the boiler = %.2f Btu per lb of steam generated",Qb)
printf("\n Heat absorbed in the superheater = %.2f Btu/lb of steam",Qs)
printf("\n Heat absorbed in steam generating = %.2f Btu/lb of steam generated",h4)
printf("\n Output of steam generating unit = %d kB",out)
printf("\n Efficiency of steam generating unit = %.1f percent",eff*100)
printf("\n Carbon burned to CO and CO2 = %.2f lb of C per lb of fuel",Cb)
printf("\n Dry products of combustion = %.2f lb per lb of fuel",dry)
printf("\n Loss due to sensible heat in dry gaseous products of combustion = %d Btu/lb of fuel",loss1)
printf("\n Loss due to CO in dry products of combustion = %.1f Btu/lb of fuel",loss2)
printf("\n Loss due to C in refuse = %.1f Btu/lb of fuel",loss3)
printf("\n Loss due to evaporating moisture in fuel = %.1f Btu/lb of fuel",loss4)
printf("\n Loss due to water vapor formed from H = %.1f Btu/lb of fuel",loss5)
printf("\n Energy absorbed in generating steam = %d Btu/lb of fuel",loss6)
disp("The answers are a bit different due to rounding off error in the textbook")
```

Chapter 6

Steam power plant cycles

Scilab code Exa 6.1 Example 1

```
clc
clear
//Initialization of variables
P1=200 //psia
T1=600 //F
P2=2 //psia
J=778
//calculations
disp("from mollier charts,")
h1=1322 //Btu/lb
h2=974 //Btu/lb
vf2=0.01623 //cu ft per lb
hf2=94 //Btu/lb
t2=126 //F
Wtj=h1-h2
Qout=h2-hf2
Wp=(P1-P2)*vf2
Wpj=Wp/J
h3=hf2+Wpj
Qin=h1-h3
etat=((h1-h2)-Wpj)/(h1-(hf2+Wpj))
```

```
eta=((h1-h2))/(h1-(hf2))
//results
printf("Efficiency of rankine cycle = %.1f percent",
   etat*100)
printf("\n Efficiency of rankine cycle neglecting
   boiler feed pump = %.1f percent",eta*100)
```

Scilab code Exa 6.2 Example 2

```
clc
clear
//Initialization of variables
B=70 //F
P1=140 //psia
x=0.986
P2=14.7 //psia
ms=2000 //lb/hr
Ihp=80
//calculations
disp("From mollier charts,")
hc=38 //Btu/lb
hf=324.82 //Btu/lb
hfg=868.2 //Btu/lb
h1=hf+x*hfg
Qin=ms*(h1-hc)
eta=Ihp*2545*100/(Qin)
Qw=Ihp*2545
Qr=Qin-Qw
per=Qr/Qin *100
//results
printf("Heat input to the boiler = %d Btu/hr",Qin)
printf("\n Cycle efficiency = %.1f percent",eta)
printf("\n Heat rejected to waste = %d Btu/hr or %.1
   f percent of Qin",Qr,per)
disp("The answer is a bit different due to rounding
```

```
off error in textbook")
```

Scilab code Exa 6.3 Example 3

```
clc
clear
//Initialization of variables
B=70 //F
P1=140 //psia
x=0.986
P2=14.7 //psia
ms=2000 //lb/hr
Ihp=80
//calculations
disp("From mollier charts,")
hc=180 //Btu/lb
hf=324.82 //Btu/lb
hfg=868.2 //Btu/lb
h1=hf+x*hfg
Qin=ms*(h1-hc)
eta=Ihp*2545*100/(Qin)
Qw=Ihp*2545
Qr=Qin-Qw
per=Qr/Qin *100
//results
printf("Heat input to the boiler = %d Btu/hr",Qin)
printf("\n Cycle efficiency = %.2f percent",eta)
printf("\n Heat rejected to waste = %d Btu/hr or %.2f percent of Qin",Qr,per)
disp("The answer is a bit different due to rounding off error in textbook")
```

Scilab code Exa 6.4 Example 4

```
clc
clear
//Initialization of variables
m=1.24 //lb
HV=11300 //Btu/lb
//calculations
HR=m*HV
eff=3413/HR
//results
printf("Plant heat rate = %d Btu/kw hr",HR)
printf("\n Overall efficiency = %.1f percent",eff
   *100)
```

Chapter 7

Steam turbines

Scilab code Exa 7.1 Example 1

```
clc
clear
//Initialization of variables
P1=200 //psia
T1=500 //psia
m=1 //lb /s
P4=140 //psia
P11=1 //psia
x=0.808
//calculations
disp("From mollier charts,")
h1=1268.9 //Btu/lb
h4=1234.7 //Btu/lb
V4=223.8*sqrt(h1-h4)
v4=3.584 //cu ft/lb
A4=m*v4/V4
h11=907.4 //Btu/lb
V11=223.8*sqrt(h1-h11)
vf=0.01614 //cu ft/lb
vg=333.6 //cu ft/lb
vfg=vg-vf
```

```
v11=x*vg
A11=m*v11/V11
//results
printf("Area of nozzle = %.5f sq ft",A4)
printf("\n Area of nozzle = %.4f sq ft",A11)
```

Scilab code Exa 7.4 Example 4

```
clc
clear
//Initialization of variables
P1=200 //psia
T1=500 //F
P2=1 //psia
alpha=20 //degrees
n=3600
g=32.2 //ft/s^2
//calculations
disp("From mollier charts,")
V1=4240 //fps
Vb=V1*cosd(alpha) /2
R=Vb*60/(n*2*%pi)
work=1/32.2 *(V1*cosd(alpha))*Vb
eff=work/(V1^2 /(2*g)) *100
//results
printf("Blade velocity = %d fps",Vb)
printf("\n Blade radius = %.1f ft",R)
printf("\n Work done = %d ft-lb per lb of steam",
   work)
printf("\n Blade efficiency = %.1f percent",eff)
disp("The answers are a bit different due to
   rounding off error in textbook.")
```

Scilab code Exa 7.5 Example 5

```
clc
clear
//Initialization of variables
P1=200 //psia
T1=500 //F
P2=1 //psia
alpha=20 //degrees
n=3600
g=32.2 //ft/s^2
Vb=1200 //fps
//calculations
disp("From mollier charts,")
V1=4240 //fps
V1x=3980 //fps
V2x=-1580 //fps
work=1/32.2 *(V1x - V2x)*Vb
eff=work/(V1^2 /(2*g)) *100
//results
printf("\n Work done = %d ft-lb per lb of steam",
   work)
printf("\n Blade efficiency = %.1f percent",eff)
disp("The answers are a bit different due to
   rounding off error in textbook.")
```

Scilab code Exa 7.6 Example 6

```
clc
clear
//Initialization of variables
P1=200 //psia
T1=500 //F
P2=1 //psia
alpha=20 //degrees
```

```
n=3600
g=32.2 //ft/s^2
//calculations
disp("From mollier charts,")
V1=2450 //fps
Vb=V1*cosd(alpha) /2
R=Vb*60/(n*2*%pi)
work=1/32.2 *(V1*cosd(alpha))*Vb
w3=3*work
//results
printf("Blade velocity = %d fps",Vb)
printf("\n Blade radius = %.2f ft",R)
printf("\n Work done = %d ft-lb per lb of steam",w3)
disp("The answers are a bit different due to
    rounding off error in textbook.")
```

Scilab code Exa 7.7 Example 7

```
clc
clear
//Initialization of variables
P1=200 //psia
T1=500 //F
P2=1 //psia
alpha=20 //degrees
n=3600
g=32.2 //ft/s^2
stage=2
//calculations
disp("From mollier charts,")
V1=4240 //fps
Vb=V1*cosd(alpha) /(2*stage)
R=Vb*60/(n*2*%pi)
V1x=3980 //fps
V2x=-1990 //fps
```

```
work1=1/g *(V1x-V2x)*Vb
work2=1/g *(-V2x)*Vb
wt=work1+work2
//results
printf("Blade velocity = %d fps",Vb)
printf("\n Blade radius = %.2f ft",R)
printf("\n Total Work done = %d ft-lb per lb of
    steam",wt)
disp("The answers are a bit different due to
    rounding off error in textbook.")
```

Scilab code Exa 7.8 Example 8

```
clc
clear
//Initialization of variables
alpha=20 //degrees
n=3600
g=32.2 //ft/s^2
V1=500 //fps
//calculations
Vb=V1*cosd(alpha)
V1x=Vb
work=1/32.2 *(V1x)*Vb
//results
printf("Blade velocity = %d fps",Vb)
printf("\n Work done = %d ft-lb per lb of steam",
    work)
disp("The answers are a bit different due to
    rounding off error in textbook.")
```

Scilab code Exa 7.9 Example 9

```
clc
clear
//Initialization of variables
pow=1000 //kw
ms=16000 //lb/hr
P=200 //psia
T=540 //F
//calculations
disp("From mollier charts,")
h1=1290 //Btu/hr
h2=940 //Btu/hr
dh=h1-h2
rate=3413/dh
act=ms/pow
//results
printf("Ideal steam rate = %.2f lb per kw hr",rate)
printf("\n Actual steam rate = %d lb per kw hr",act)
```

Scilab code Exa 7.10 Example 10

```
clc
clear
//Initialization of variables
P=200 //psia
T=540 //F
pow=1000 //kw
ms=16000 //lb/hr
//calculations
disp("From mollier charts,")
h1=1290 //Btu/hr
h2=940 //Btu/hr
dh=h1-h2
hf2=83 //Btu/lb
etat=(h1-h2)/(h1-hf2)
act=pow*3413/(ms*(h1-hf2))
```

```
etae=act/etat
//results
printf("Ideal thermal efficiency = %.1f percent",
   etat*100)
printf("\n Actual thermal efficiency = %.1f percent"
   ,act*100)
printf("\n Engine efficiency = %.1f percent",etae
   *100)
```

Chapter 8

Steam engines

Scilab code Exa 8.1 Example 1

```
clc
clear
//Initialization of variables
area1=2.7
len=3.4
scale=60
area2=2.75
dia=12 //ft
d2=2.5 //ft
L=15/12 //ft
n=250 //rpm
F=600 //lb
r=3 //ft
//calculations
Ah=dia^2 *%pi/4
Ac=(dia^2 -d2^2)*%pi/4
Pih=area1/len *scale
Pic=area2/len *scale
Hihp=Pih*L*Ah*n/33000
Cihp=Pic*L*Ac*n/33000
Tihp=Hihp+Cihp
```

```
Bhp=2*%pi*r*F*n/33000
Fhp=Tihp-Bhp
eff=Bhp/Tihp *100
//results
printf("Ihp = %.1f ihp",Tihp)
printf("\n Bhp = %.1f bhp",Bhp)
printf("\n Fhp = %.1f fhp",Fhp)
printf("\n Efficiency = %.1f percent",eff)
disp("The answer is a bit different due to rounding
    off error in the textbook.")
```

Scilab code Exa 8.2 Example 2

```
clc
clear
//Initialization of variables
Ihp=101.1
Bhp=85.7
md=3000 //lb/hr
h1=1172 //Btu/hr
h2=180 //Btu/hr
h3=1025 //Btu/hr
//calculations
eta1=Ihp*2545/(md*(h1-h2)) *100
eta2=Bhp*2545/(md*(h1-h2)) *100
etat=(h1-h3)/(h1-h2) *100
engeff=eta1/etat *100
rate1= md/Ihp
rate2=md/Bhp
h22=h1-2545/rate1
//results
printf("Actual thermal efficiency based upon Ihp = %
    .2f lb per ihp hr",eta1)
printf("\n Actual thermal efficiency based upon Bhp
    = %.2f lb per ihp hr",eta2)
```

```
printf("\n Ideal thermal efficiency = %.2f percent "
   ,etat)
printf("\n Engine efficiency = %.1f percent",engeff)
printf("\n Steam rate = %.2f lb per ihp hr",rate1)
printf("\n Steam rate = %.2f lb per bhp hr",rate2)
printf("\n Enthalpy of exhaust steam = %d Btu/lb of
   steam",h22)
```

Chapter 9

Pumps

Scilab code Exa 9.1 Example 1

```
clc
clear
//Initialization of variables
h=200 //ft
gam=64 //lb per cu ft
//calculations
P=h*gam/144
//results
printf("Pressure = %.1f psi",P)
```

Scilab code Exa 9.2 Example 2

```
clc
clear
//Initialization of variables
P=20 //psi
gam=62.4 //lb per cu ft
//calculations
```

```
h=P*144/gam
//results
printf("height = %.1f ft",h)
```

Scilab code Exa 9.3 Example 3

```
clc
clear
//Initialization of variables
h=3/12 //ft
gam=63.4 //lb per cu ft
gam2=0.075 //lb per cu ft
//calculations
P=h*gam
h2=P/gam2
//results
printf("Air height required = %d ft of air",h2)
disp("The answer is a bit different due to roundoff
   error in textbook.")
```

Scilab code Exa 9.4 Example 4

```
clc
clear
//Initialization of variables
dif=4 //in
gam=62.4 //lb per cu ft
density=13.6 //g/cc
//calculations
pv=dif*1/12 *density*gam/144 - dif/12 *gam/144
hv=pv*144/gam
//results
printf("velocity pressure = %.2f psi",pv)
```

```
printf("\n velocity head = %.1f ft of water ",hv)
```

Scilab code Exa 9.5 Example 5

```
clc
clear
//Initialization of variables
dif=4 //in
gam=62.4 //lb per cu ft
gam2=0.08 //lb per cu ft
//calculations
pv=dif*1/12 *gam/144
hv=pv*144/gam2
//results
printf("velocity pressure = %.3f psi",pv)
printf("\n velocity head = %.1f ft of air ",hv)
```

Scilab code Exa 9.6 Example 6

```
clc
clear
//Initialization of variables
hw=3/12 //ft
gam1=62.4 //lb/ft^3
gam2=0.07 //lb/ft^3
g=32.2 //ft/s^2
//calculations
p=hw*gam1
hg=p/gam2
V=sqrt(2*g*hg)
//results
printf("velocity of gas = %.1f fps",V)
```

Scilab code Exa 9.7 Example 7

```
clc
clear
//Initialization of variables
h=4 //in
den=13.6 //g/cc
Ar=1/9
A1=12 //sq in
gam=62.4 //lb/ft^3
g=32.2 //ft/s^2
//calculations
dh=(h*den-h)/12
Vr=1/Ar
V22=2*g*dh/(1-Ar^2)
V2=sqrt(V22)
A2=A1*Ar
v2=1/gam
ms=A2*V2/(v2*144)
//results
printf("Flow rate of water = %.1f lb/sec",ms)
```

Scilab code Exa 9.8 Example 8

```
clc
clear
//Initialization of variables
mdot=8000 //lb/min
A1=1 //sq ft
A2=3/4 //sq ft
P2=50 //psi
P1=10 //psi
```

```
gam=62.4 //lb/ft^3
y2=-2 //ft
y1=-4 //ft
g=32.2 //ft/s^2
eff=0.7
//calculations
v=1/gam
cap=mdot/8.33
V1=mdot*v/A1 /60
V2=mdot*v/A2 /60
ht= (y2-y1) + (V2^2 -V1^2)/(2*g) + (P2-P1)*144/gam
Hhp=mdot*ht/33000
Php=Hhp/eff
//results
printf("Capacity = %d gpm",cap)
printf("\n Total dynamic head = %.1f ft",ht)
printf("\n Hydraulic hp = %.1f hp",Hhp)
printf("\n pump hp = %.1f hp",Php)
```

Scilab code Exa 9.9 Example 9

```
clc
clear
//Initialization of variables
z=12 //ft
gam1=62.4 //lb/ft^3
sg=0.8
P2=100 //psia
P1=-10 //psia
mm=10000 //lb/min
//calculations
gam2=sg*gam1
p2g=P2*144/(gam2) +z
p1g=P1*144*0.491/(gam2)
ht=p2g-p1g
```

```
Hhp=mm*ht/33000
//results
printf("Total dynamic head = %.1f ft of oil",ht)
printf("\n Hydraulic hp = %.1f hp",Hhp)
```

Scilab code Exa 9.10 Example 10

```
clc
clear
//Initialization of variables
sr=2
//calculations
hr=sr^2
capr=sr
hpr=sr^3
//results
printf("head is %d times the original",hr)
printf("\n capacity is  %d times the original",capr)
printf("\n power is  %d times the original",hpr)
```

Chapter 10

Drafts fans blowers and compressors

Scilab code Exa 10.1 Example 1

```
clc
clear
//Initialization of variables
hb=29 //in of Hg
sg=0.491
Ra=53.3
Ta=460+40 //R
Tg=540+460 //R
H=300 //ft
gam=62.4 //lb/cu ft
//calculations
pb=hb*sg*144
rhoa=pb/(Ra*Ta)
rhog=pb/(Ra*Tg)
dp=H*(rhoa-rhog)
D=dp/(gam)
//results
printf("Theoretical draft = %.1f psf",dp)
printf("\n Draft = %.2f ft H2O",D)
```

Scilab code Exa 10.2 Example 2

```
clc
clear
//Initialization of variables
md=15 //lb per lb of coal
x=0.1
mss=1 //basis
rea=29 //in of Hg
sg=0.491
R=53.3
T=540+460 //R
V=25 //fps
gam=0.038 //lb/ft^3
//calculations
m=mss-mss*x+md
ms=m
rhog=rea*0.491*144/(R*T)
A=ms/(gam*V)
//results
printf("stack area = %.1f sq ft",A)
```

Scilab code Exa 10.3 Example 3

```
clc
clear
//Initialization of variables
p=144*29*0.491 //psf
R=53.3
T=70+460 //R
gamw=62.4 //lb/ft^3
```

```
gama=0.073 //lb/ft^3
hw=3/12 //ft
hw2=3.5/12 //ft
hv=32.2 //ft/s^2
ms=9 //lb
g=32.2 //ft/s^2
//calculations
rhoa=p/(R*T)
hs=hw*gamw/gama
ht=hw2*gamw/gama
hv=ht-hs
V=sqrt(2*g*hv)
msv=ms*V*60
mm=msv*gama
airhp= ht*mm/33000
//results
printf("Velocity head = %d ft of air",hv)
printf("\n velocity of air in the duct = %.1f fps",V
   )
printf("\n volume = %d cu ft per min",msv)
printf("\n Mass flow rate = %d lb/min",mm)
printf("\n Air hp = %.1f hp",airhp)
disp("The answers in the textbook are a bit
   different due to rounding off error in the
   textbook. Please use a calculator")
```

Scilab code Exa 10.4 Example 4

```
clc
clear
//Initialization of variables
A2=9 //sq ft
p2=3/12 *62.4 //psf
p1=-1/12 *62.4 //psf
ms=20000 //cfm
```

```
A1=16 //sq ft
gam=0.075 //lb/ft^3
g=32.2 //ft/s^2
inp=17 //hp
//calculations
V2=ms/60 *1/A2
V1=ms/60 *1/A1
ht=(p2-p1)/gam +(V2^2 -V1^2)/(2*g)
airhp=ht*ms*gam/33000
eta=airhp/inp *100
//results
printf("Total head = %.1f ft of air",ht)
printf("\n Air hp = %.1f hp",airhp)
printf("\n Effifciency = %.1f percent",eta)
```

Scilab code Exa 10.5 Example 5

```
clc
clear
//Initialization of variables
n1=400 //rpm
mv1=10000 //lb
mv2=15000 //lb
h1=2 //in of water
hp1=4 //hp
//calculations
n2=mv2/mv1 *n1
h2=h1*(n2/n1)^2
hp2=hp1 *(n2/n1)^3
//results
printf("The speed = %d rpm",n2)
printf("\n The pressure = %.1f in of water",h2)
printf("\n Power = %.1f hp",hp2)
```

Scilab code Exa 10.6 Example 6

```
clc
clear
//Initialization of variables
m=100000 //lb/hr
p1=1 //psia
x=0.8
p2=14.7 //psia
t2=300 //F
//calculations
disp("from table A3 and A2")
h2=1192.8 //Btu/lb
hf=69.7 //Btu/lb
hfg=1036.3 //Btu/lb
h1=hf+x*hfg
W=h2-h1
power=m*W
hp=power/2545
//results
printf("Power required = %d hp",hp)
```

Scilab code Exa 10.7 Example 7

```
clc
clear
//Initialization of variables
p1=14.7 //psia
t1=60 //F
p2=60 //psia
t2=440 //F
m=10 //lb/sec
```

```
//calculations
disp("From mollier charts,")
h2=216.3 //Btu/lb
h1=124.3 //Btu/lb
W21=h2-h1
power=W21*m
hp=power*3600/2545
cp=0.237
W212=cp*(t2-t1)
power2=W212*m
hp2=power2*3600/2545
//results
printf("Power required = %d hp",hp)
printf("\n Power required = %d hp",hp2)
printf("\n Work done = %.1f Btu/lb",W212)
```

Chapter 11

Feed water heaters and condensers

Scilab code Exa 11.1 Example 1

```
clc
clear
//Initialization of variables
m1=1000 //lb/hr
m2=5000 //lb/hr
m3=3000 //lb/hr
//calculations
disp("From mollier charts,")
h5=196.16 //Btu/lb
h1=38.04 //Btu/lb
h2=67.97 //Btu/lb
h3=117.89 //Btu/lb
h4=1156.3 //Btu/lb
m4=(m1*h1+m2*h2+m3*h3-(m1+m2+m3)*h5)/(h5-h4)
//results
printf("Pounds of steam entering the heater = %d lb/
   hr",m4)
```

Scilab code Exa 11.2 Example 2

```
clc
clear
//Initialization of variables
P1=100 //psia
T1=400 //F
T2=70 //F
//calculations
disp("From mollier charts,")
h1=1227.6 //Btu/lb
h2=298.4 //Btu/lb
h3=279.9 //Btu/lb
h4=38.04 //Btu/lb
m1=(h3-h4)/(h1-h2)
//results
printf("Mass of steam required = %.2f lb steam per
    lb water",m1)
```

Scilab code Exa 11.3 Example 3

```
clc
clear
//Initialization of variables
h0=1260 //Btu/lb
msr=15 //lb
m4=15 //lb per hr per kw
t2=80 //F
t3=60 //F
//calculations
h1=h0-3413/msr
disp("from mollier charts,")
```

```
h4=58 //Btu/lb
dt=t2-t3
m3=m4*(h1-h4)/dt
//results
printf("enthalpy of steam entering the condenser =
    %d Btu/lb",h1)
printf("\n mass of cooling water = %d lb per hr per
    kw",m3)
```

Scilab code Exa 11.4 Example 4

```
clc
clear
//Initialization of variables
m4=8*1000000 //lb per hr
dt=12 //F
//calculations
disp("from mollier charts,")
dh4=950 //Btu/lb
m3=m4*(dh4)/dt
//results
printf("\n mass of cooling water = %.3e lb per hr",
    m3)
```

Chapter 12

The Gas turbine power plant

Scilab code Exa 12.1 Example 1

```
clc
clear
//Initialization of variables
T1=80 //F
T2=460 //F
T3=1300 //F
T4=780 //F
//calculations
disp("from mollier charts,")
h1=129.1 //Btu/lb
h2 = 221.2 //Btu/lb
h3= 438.8 //Btu/lb
h4 = 301.5 //Btu/lb
wcom=h2-h1
wcob=h3-h2
wtur=h3-h4
eta=(wtur-wcom)/wcob *100
//results
printf("\n work done by compressor = %.1f btu input
   as work per lb of air compressed",wcom)
printf("\n Heat supplied in the combustor = %.1f Btu
```

```
    supplied per lb of air ",wcob)
printf("\n work done in the turbine = %.1f Btu
   output as work per lb of air",wtur)
printf("\n Cycle efficiency = %.1f percent",eta)
```

Scilab code Exa 12.2 Example 2

```
clc
clear
//Initialization of variables
T1=80 //F
T2=460 //F
T=700 //F
T3=1300 //F
T4=780 //F
//calculations
disp("from mollier charts,")
h1=129.1 //Btu/lb
h2 = 221.2 //Btu/lb
h3= 438.8 //Btu/lb
h4 = 301.5 //Btu/lb
wcom=h2-h1
wcob=h3-h2
wtur=h3-h4
output=-wcom+wtur
h=281.1 //Btu/lb
Q=h3-h
eff=output/Q *100
//results
printf("\n Heat supplied in the combustor = %.1f Btu
    supplied per lb of air ",Q)
printf("\n Cycle efficiency = %.1f percent",eff)
```

Chapter 13

Mechanical Refrigeration

Scilab code Exa 13.1 Example 1

```
clc
clear
//Initialization of variables

disp("From mollier diagram from ammonia, values are
   found")
disp("part a")
h1=65 //Btu/lb
printf("enthalpy in case a = %d Btu/lb",h1)
h2=99 //Btu/lb
v2=0.93 //ft^3/lb
printf("\n In case 2, enthalpy and specific volume
   are %d Btu/lb and %.2f ft^3/lb respectively",h2,
   v2)
h3=583 //Btu/lb
v3=8.8 //ft^3/lb
s3=1.275
printf("\n In case 3, enthalpy, specific volume and
   entropy are %d Btu/lb, %.2f ft^3/lb and %.3f
   respectively",h3,v3,s3)
h4=720 //Btu/lb
```

```
v4=10.4 //ft^3/lb
s4=1.50
printf("\n In case 4, enthalpy, specific volume and
    entropy are %d Btu/lb, %.2f ft^3/lb and %.3f
    respectively",h4,v4,s4)
```

Scilab code Exa 13.2 Example 2

```
clc
clear
//Initialization of variables
mr=3 //lb
mj=5 //lb
t2=67 //F
t1=60 //lb
ihp=7.25
//calculations
disp("From mollier charts,")
h4=709 //Btu/b
h3=618 //Btu/lb
energyin=ihp*2545/60
energyout=mr*(h4-h3) + mj*(t2-t1)
//results
printf("Energy in = %.1f Btu/min",energyin)
printf("\n Energy out = %.1f Btu/min",energyout)
```

Scilab code Exa 13.3 Example 3

```
clc
clear
//Initialization of variables
mr=3 //lb
hp=10 //hp
```

```
//calculations
h3=618 //Btu/lb
h1=131 //Btu/lb
Qe=mr*(h3-h1)
work=hp*2545/60
cop=Qe/work
//results
printf("Coefficient of performance = %.2f",cop)
```