

Scilab Textbook Companion for
Mechanical Engineering Thermodynamics
by D. A. Mooney¹

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July 31, 2019

¹Funded 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: Mechanical Engineering Thermodynamics

Author: D. A. Mooney

Publisher: Prentice Hall

Edition: 5

Year: 1980

ISBN: 1466511796

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 2

Work

Scilab code Exa 2.1 example 1

```
1 clc
2 // Initialization of variables
3 g=1.4
4 P=100 //psia
5 V1=3 //cu ft
6 Pf=20 //psia
7 //calculations
8 V2=V1*(P/Pf)^(1/g)
9 W=(Pf*V2-P*V1)*144/(1-g)
10 //results
11 printf("Net work done = %d ft",W)
```

Scilab code Exa 2.2 example 2

```
1 clc
2 // Initialization of variables
3 Wb=-33000 //ft-lb
4 V2=3 //cu ft
```

```
5 V1=1 //cu ft
6 P=69.4 //psia
7 //calculations
8 Wa=P*(V2-V1)*144
9 W=Wa+Wb
10 //results
11 printf("Net work done = %d ft-lb",W)
```

Scilab code Exa 2.3 example 3

```
1 clc
2 //Initialization of variables
3 b=11 //in
4 s=15 //in
5 l=2.4 //in
6 k=80 //psi per in
7 //calculations
8 a=%pi*b^2 /4
9 L=s/12
10 Pm=1.6/l *k
11 W=Pm*a*L
12 //results
13 printf("Net work done = %d ft lb",W)
```

Chapter 3

Temperature and Heat

Scilab code Exa 3.1 example 1

```
1 clc
2 // Initialization of variables
3 T1=500 //F
4 T2=100 //F
5 Tf=75 //F
6 cpi=0.120 //B/lb F
7 cpw=1.0 //B/lb F
8 // calculations
9 Qw=1*cpw*(T2-Tf)
10 Qi=-1*cpi*(T2-T1)
11 mw=Qi/Qw
12 // results
13 printf("Mass of water = %.2f lb water/lb iron",mw)
```

Scilab code Exa 3.2 example 2

```
1 clc
2 // Initialization of variables
```

```

3 m=5 //lb
4 T1=1540+460 //R
5 T2=540+460 //R
6 //calculations
7 function [cp]=q(T)
8     cp=m*(0.248+0.448*10^-8 *T^2)
9 endfunction
10 Q=intg(T1,T2,q)
11 //results
12 printf("Heat transferred = %d Btu",Q)

```

Scilab code Exa 3.3 example 3

```

1 clc
2 //Initialization of variables
3 Tm=235 //F
4 Tb=832 //F
5 T=70 //F
6 cps=0.18 //B/lb F
7 cpl=0.235 //B/lb F
8 Lf=15.8 //B/lb
9 Lv=120 //B/lb
10 m=10 //lb
11 //calculations
12 Qa=m*cps*(Tm-T)
13 Qb=m*Lf
14 Qc=m*cpl*(Tb-Tm)
15 Qd=m*Lv
16 Q=Qa+Qb+Qc+Qd
17 //results
18 printf("Heat required = %d Btu",Q)

```

Scilab code Exa 3.4 example 4

```

1  clc
2  // Initialization of variables
3  T1=22 //F
4  T2=32 //F
5  T3=40 //F
6  T4=70 //F
7  cps=0.501 //B/lb F
8  cpw=1 //B/lb F
9  Lf=143.3 //B/lb
10 m=40 //lb
11 // calculations
12 Qa=cps*(T2-T1)
13 Qb=Lf
14 Qc=cpw*(T3-T2)
15 Qd=m*cpw*(T3-T4)
16 mi=-Qd/(Qa+Qb+Qc)
17 // results
18 printf("Mass of ice required = %.2f lb ice",mi)

```

Scilab code Exa 3.5 example 5

```

1  clc
2  // Initialization of variables
3  T1=22 //F
4  T2=32 //F
5  T3=40 //F
6  T4=70 //F
7  cps=0.501 //B/lb F
8  cpw=1 //B/lb F
9  Lf=143.3 //B/lb
10 m=40 //lb
11 cp=0.092
12 mc=10
13 // calculations
14 Qa=cps*(T2-T1)

```

```
15 Qb=Lf
16 Qc=cpw*(T3-T2)
17 Qe=mc*cp*(T3-T4)
18 mi=-Qe/(Qa+Qb+Qc)
19 //results
20 printf("Extra Mass of ice required = %.3f lb ice",
        mi)
```

Chapter 5

The first law of thermodynamics

Scilab code Exa 5.1 example 1

```
1 clc
2 //initialization of variables
3 V1=10 //cu ft
4 P1=15 //psia
5 V2=5 //cu ft
6 H=34.7 //Btu
7 //calculations
8 W=P1*(V2-V1)*144
9 dE=-H-W/778
10 //results
11 printf("Internal energy change = %.1f Btu",dE)
```

Scilab code Exa 5.2 example 2

```
1 clc
2 //initialization of variables
```

```

3 dT=35 //F
4 H=34 //Btu
5 cv=1.2 //B/lb F
6 m= 2 //lb
7 //calculations
8 U=cv*dT*m
9 W=H-U
10 //results
11 printf("Work done = %d Btu",W)
12 printf("\n Internal energy change = %.1f Btu",U)

```

Scilab code Exa 5.3 example 3

```

1 clc
2 //initialization of variables
3 p=500 //psia
4 V2=0.9278 //cu ft
5 V1=0.0197 //cu ft
6 h2=1204.4 //B/lb
7 h1=449.4 //B/lb
8 //calculations
9 W=p*(V2-V1)*144
10 du=h2-h1-144*p*(V2-V1)/778
11 du2=h2-h1-W/778
12 //results
13 printf("Change in internal energy = %.1f Btu",du)
14 printf("\n Method 2, Internal energy change = %.1f
    Btu",du2)

```

Scilab code Exa 5.4.a example 4

```

1 clc
2 //initialization of variables

```



```

3 P1=75 //psia
4 P2=15 //psia
5 V1=6 //cu ft
6 g=1.2
7 m=3
8 //calculations
9 V2=V1*(P1/P2)^(1/g)
10 U=0.48*(P2*V2-P1*V1)
11 W=(P2*V2-P1*V1)*144/((1-g)*778)
12 Q=U+W
13 //results
14 printf("Heat = %.3f Btu",Q)
15 //The answer given in textbook is wrong. please
    check using a calculator

```

Scilab code Exa 5.4.b example 5

```

1 clc
2 //initialization of variables
3 P1=75 //psia
4 P2=15 //psia
5 V1=6 //cu ft
6 g=1.2
7 m=3
8 //calculations
9 Q=30 //Btu
10 V2=V1*(P1/P2)^(1/g)
11 U=0.48*(P2*V2-P1*V1)
12 W=Q-U
13 //results
14 printf("Work done = %.1f Btu",W)
15 //The answer given in textbook is wrong. please
    check using a calculator

```

Chapter 6

Flow Processes First law analysis

Scilab code Exa 6.1 example 1

```
1  clc
2  //initialization of variables
3  u1=1111.9 //Btu/lb
4  P1=170 //psia
5  v1=2.675 //cu ft/lb
6  v2=100.9 //cu ft/lb
7  z1=10 //ft
8  V1=6000/60 //ft/sec
9  Q=-1000
10 u2=914.6 //B/lb
11 P2=3 //psia
12 V2=300 //ft/sec
13 rate=2500 //lb/hr
14 //calculations
15 Wx=rate*(u1-u2 + (P1*v1-P2*v2)*144/778 +(V1^2 -V2^2)
    /(2*32.2*778) +z1/778 +Q/rate)
16 f=3.92*10^-4
17 //results
18 printf("Power output of turbine = %d B/hr",Wx)
```

```
19 printf("\n Power output in hp = %d hp",Wx*f+1)
```

Scilab code Exa 6.2 example 2

```
1 clc
2 //initialization of variables
3 w1=500 //lb/min
4 h1=132.9 //lb/min
5 h2=1150 //B/lb
6 h3=180 //B/lb
7 //calculations
8 w2=(w1*h1-w1*h3)/(h3-h2)
9 //results
10 printf("Flow rate = %.1f lb/min",w2)
```

Scilab code Exa 6.3 example 3

```
1 clc
2 //initialization of variables
3 v2=5.434 //cu ft/lb
4 v1=4.937 //cu ft/lb
5 h1=1227.6
6 h2=1223.9
7 A1=%pi/144
8 //calculations
9 Vratio=v2/v1
10 V1=sqrt(64.4*(h1-h2)*778/(Vratio^2 -1))
11 V2=V1*Vratio
12 w=A1*V1/v1
13 //results
14 printf("Average velocity at 1 = %d fps",V1)
15 printf("\n Average velocity at 2 = %d fps",V2)
16 printf("\n Rate of flow = %.2f lb/sec",w)
```


Chapter 8

Basic applications of the second law

Scilab code Exa 8.1 example 1

```
1 clc
2 //initialization of variables
3 T1=85+460 //R
4 T2=50+460 //R
5 //calculations
6 eta=(T1-T2)/T1
7 //results
8 printf("Max. efficiency = %.1f percent",eta*100)
```

Scilab code Exa 8.2 example 2

```
1 clc
2 //initialization of variables
3 T1=1050+460//R
4 T2=90+460 //R
5 //calculations
```

```
6 eta=(T1-T2)/T1
7 //results
8 printf("Max. possible efficiency = %d percent",eta
    *100)
```

Scilab code Exa 8.3 example 3

```
1 clc
2 //initialization of variables
3 T1=50+460 //R
4 T2=150+460 //R
5 m=1
6 cp=0.240
7 //calculations
8 ds=m*cp*(log(T2) - log(T1))
9 //results
10 printf("Change in entropy = %.4f B/ F abs",ds)
```

Scilab code Exa 8.4 example 4

```
1 clc
2 //initialization of variables
3 T1=50+460 //R
4 T2=150+460 //R
5 m=1
6 cp=0.240
7 //calculations
8 ds=m*cp*(log(T2) - log(T1))
9 //results
10 printf("Change in entropy = %.4f B/ F abs",ds)
```

Scilab code Exa 8.5 example 5

```
1 clc
2 //initialization of variables
3 Q=826 //B/lb
4 T=860 //R
5 T1=2000+460 //R
6 T2=1000+460 //R
7 //calculations
8 ds=Q/T
9 dsgas=Q*(log(T2)-log(T1))/(T1-T2)
10 dst=ds+dsgas
11 //results
12 printf("Total entropy change = %.3f B/R",dst)
```

Scilab code Exa 8.6 example 6

```
1 clc
2 //initialization of variables
3 T0=540 //R
4 Q=826 //B/lb
5 ds=0.534
6 ds2=0.431
7 //calculations
8 tds=T0*ds
9 tds2=T0*ds2
10 H=Q-tds2
11 Loss=tds/H
12 //results
13 printf("Loss = %d percent",Loss*100+1)
```

Chapter 10

Tabulated properties Steam Tables

Scilab code Exa 10.1 example 1

```
1 clc
2 //initialization of variables
3 P=100 //psia
4 hfg=888.8 //B/lb
5 //calculations
6 disp("From steam tables ,")
7 vg=4.432 //cu ft/lb
8 vf=0.001774 //cu ft/lb
9 W=P*(vg-vf)*144
10 ufg=807.1 //B/lb
11 W=hfg-ufg
12 sfg=1.1286
13 Q=788*sfg
14 //results
15 printf("Work done = %.1f B/lb",W)
16 printf("\\n Heat of vaporization of water = %d B/lb",
    Q)
```

Scilab code Exa 10.2 example 2

```
1 clc
2 //initialization of variables
3 s=1.6315 //B/lb R
4 //calculations
5 disp("From table 1 ")
6 h=1180.6 //B/lb
7 t=302.92 //F
8 p=70 //psia
9 //results
10 printf(" Pressure = %d psia",p)
11 printf(" \n Temperature = %.2f F",t)
12 printf(" \n Enthalpy = %.1f B/lb",h)
```

Scilab code Exa 10.3 example 3

```
1 clc
2 //initialization of variables
3 T=250 //F
4 disp("From table 1,")
5 p=29.825 //psia
6 hg=1164 //B/lb
7 vg=13.821 //cu ft/lb
8 //calculations
9 ug=hg-(p)*144*vg/778
10 //results
11 printf(" Internal energy of the gas = %.1f B/lb",ug)
```

Scilab code Exa 10.4 example 4

```
1 clc
2 //initialization of variables
3 x=0.4
4 P=100 //psia
5 //calculations
6 y=1-x
7 disp("From table 2,")
8 vf=0.01774
9 vg=4.432
10 vx=x*vf+y*vg
11 hf=298.4
12 hfg=888.8
13 hx=hf+y*hfg
14 sg=1.6026
15 sfg=1.1286
16 sx=sg-x*sfg
17 //results
18 printf(" Specific volume = %.3f cu ft/lb",vx)
19 printf(" \n Enthalpy = %.1f B/lb",hx)
20 printf(" \n Entropy = %.4f B/lb R",sx)
```

Scilab code Exa 10.5 example 5

```
1 clc
2 //initialization of variables
3 x=0.97
4 P=100 //psia
5 //calculations
6 disp("From table 2,")
7 hf=298.4
8 hfg=888.8
9 hx=hf+x*hfg
10 hg=1187.2
```

```
11 hx2=hg-(1-x)*hfg
12 //results
13 printf("Accurate Enthalpy = %.1f B/lb",hx2)
14 printf("\n Enthalpy = %.1f B/lb", hg)
```

Scilab code Exa 10.6 example 6

```
1 clc
2 //initialization of variables
3 s=1.7050 //B/lb R
4 //calculations
5 disp("From table 2,")
6 sx=1.7050
7 sg=1.7549
8 sfg=1.4415
9 dx=(sg-sx)/sfg
10 hg=1150.8
11 hfg=969.7
12 hx=hg-dx*hfg
13 vg=26.29
14 vfg=26.27
15 vx=vg-dx*vfg
16 //results
17 printf("Specific volume = %.3f cu ft/lb",vx)
18 printf("\n Enthalpy = %.1f B/lb",hx)
```

Scilab code Exa 10.7 example 7

```
1 clc
2 //initialization of variables
3 P=150 //psia
4 T=400 //F
5 //calculations
```

```
6 disp("From table 3,")
7 h=1219.4 //B/lb
8 //results
9 printf("Enthalpy = %.1f B/lb",h)
```

Scilab code Exa 10.8 example 8

```
1 clc
2 //initialization of variables
3 en=1303.7 //B/lb
4 P=300 //psia
5 //calculations
6 disp("Given hg is less than h, steam is superheated.
      T=580 F")
7 T=580 //F
8 //results
9 printf("Temperature = %d F",T)
```

Scilab code Exa 10.10 example 10

```
1 clc
2 //initialization of variables
3 T=100 //F
4 P=1000 //psia
5 //calculations
6 disp("From table 4")
7 dvf=-5.1*10^-5
8 dhf=2.7
9 vf=0.01613
10 hf=67.97
11 v=vf+dvf
12 h=hf+dhf
13 //results
```

```
14 printf("Enthalpy = %.2f B/lb",h)
15 printf("\n Volume = %.5f cu ft/lb",v)
```

Scilab code Exa 10.11 example 11

```
1 clc
2 //initialization of variables
3 h1=1183.2 //B/lb
4 hg=1198.4 //B/lb
5 hfg=843
6 //calculations
7 x=1- (hg-h1)/hfg
8 //results
9 printf("Quality = %.3f",x)
```

Chapter 11

Properties of Gases

Scilab code Exa 11.1 example 1

```
1 clc
2 //initialization of variables
3 P1=15 //psia
4 T1=80+460 //R
5 dm=3 //lb
6 T2=75+460 //R
7 P2=25 //psia
8 //calculations
9 mratio=P1*T2/(P2*T1)
10 m2=dm/(1-mratio)
11 V2=m2*55.16*T2/(P2*144)
12 //results
13 printf("Volume of the apparatus = %.1f cu ft",V2)
```

Scilab code Exa 11.2 example 2

```
1 clc
2 //initialization of variables
```

```

3 R=48.3 //ft lb/lb R
4 k=1.4
5 //calculations
6 dc=R/778
7 cp=k*dc/(k-1)
8 cv=cp/k
9 //results
10 printf(" Specific heat at constant volume = %.3 f B/lb
        R" ,cv)
11 printf(" Specific heat at constant pressure = %.3 f B/
        lb R" ,cp)

```

Scilab code Exa 11.4 example 4

```

1 clc
2 //initialization of variables
3 P1=100 //psia
4 P2=10 //psia
5 T1=140 +460 //R
6 g=1.4
7 cp=0.248
8 //calculations
9 dh=g*55.16*T1*((P2/P1)^((g-1)/g) -1)/(g-1)
10 T2=T1*(P2/P1)^((g-1)/g)
11 dh2=cp*(T2-T1)
12 //results
13 printf("In method 1, Enthalpy = %d Btu/lb",dh
        *0.01286)
14 printf("\n In method 2, Enthalpy = %.1 f ft lb/lb",
        dh2)

```

Scilab code Exa 11.5.a example 5

```

1  clc
2  //initialization of variables
3  P1=100 //psia
4  T1=2000+460 //R
5  P2=15 //psia
6  g=1.4
7  cp=0.24
8  //calculations
9  v1=53.34*T1/(P1*144)
10 v2=53.34*T1*(P1/P2)^(1/g) /(P1*144)
11 T2=T1*P2*v2/(P1*v1)
12 dh=cp*(T2-T1)
13 dv=v2-v1
14 //results
15 printf("Change in enthalpy = %d B/lb",dh)
16 printf("\\n Specific volume change = %.1f cu ft/lb",
        dv)

```

Scilab code Exa 11.5.b example 6

```

1  clc
2  //initialization of variables
3  P1=100 //psia
4  T1=2000+460 //R
5  P2=15 //psia
6  g=1.4
7  cp=0.276
8  cv=0.207
9  T2=1520 //R
10 //calculations
11 k=cp/cv
12 v1=53.34*T1/(P1*144)
13 v2=v1*(P1/P2)^(1/k)
14 dh=cp*(T2-T1)
15 dv=v2-v1

```



```
16 //results
17 printf("Enthalpy change = %d B/lb",dh)
18 printf("\n Volume change = %.1f cu t/lb",dv)
```

Scilab code Exa 11.5.c example 7

```
1  clc
2  //initialization of variables
3  P1=100 //psia
4  T1=2000+460 //R
5  P2=15 //psia
6  g=1.4
7  cp=0.276
8  cv=0.207
9  T2=1520 //R
10 //calculations
11 h1=634.4
12 pr1=407.3
13 pr2=pr1*P2/P1
14 disp("From table 1,")
15 T2=1535 //R
16 h2=378.44
17 dh=h2-h1
18 v1=53.34*T1/(P1*144)
19 v2=53.34*T2/(P2*144)
20 dv=v2-v1
21 //results
22 printf("Enthalpy change = %.2f B/lb",dh)
23 printf("\n Volume change = %.1f cu ft/lb",dv)
```

Chapter 12

Properties of Gaseous Mixtures

Scilab code Exa 12.1 example 1

```
1  clc
2  //initialization of variables
3  P=15 //psia
4  T2=70+460 //R
5  T1=55+460 //R
6  //calculations
7  pw=0.2141
8  pA=P-pw
9  mratio=pA*29/(pw*18)
10 mAbym=mratio/(1+mratio)
11 mwbym=1/(1+mratio)
12 pg=0.3631 //psia
13 phi=pw/pg
14 gamma=1/mratio
15 //results
16 printf("Partial pressure of water vapor = %.2f psia"
    ,pA)
17 printf("\n Specific humidity = %.4f lb vapor/lb air"
    ,gamma)
```

Scilab code Exa 12.2 example 2

```
1  clc
2  //initialization of variables
3  rh=0.75
4  pg=0.5069
5  inc=10 //in
6  pA=29.50 //psia
7  //calculations
8  pw=rh*pg
9  p=(29.50+ inc/13.6)*0.491
10 pA=p-pw
11 mratio=pw*18/(pA*29)
12 //results
13 printf("Pounds of water vapor enter the surface per
    pound of dry air = %.4f lb vapor/lb air",mratio)
```

Chapter 13

process calculations for stationary systems

Scilab code Exa 13.1.a example 1

```
1  clc
2  //initialization of variables
3  P1=100 //psia
4  T1=500+460 //R
5  v=10 //cu ft
6  P2=50 //psia
7  cv=0.172
8  R=53.34
9  m=2.81 //lb
10 //calculations
11 T2=T1*P2/P1
12 Q1=P1*144*v*cv*(T2-T1)/(R*T1)
13 u1=165.26
14 u2=81.77
15 du=u2-u1
16 Q2=m*du
17 //results
18 printf("Case 1,")
19 printf("\n Final temperature of the steam = %d R",T2
```

```

    )
20 printf("\n Heat transferred = %d Btu",Q1+1)
21 printf("\n Heat transferred in case 2 = %d Btu",Q2
    -1)

```

Scilab code Exa 13.1.b example 2

```

1  clc
2  //initialization of variables
3  P1=100 //psia
4  T1=500+460 //R
5  V=10 //cu ft
6  P2=50 //psia
7  cv=0.172
8  R=53.34
9  v=5.589 //cu ft/lb
10 //calculations
11 m=V/v
12 x2=(v-0.017)/8.498
13 disp("From table 2,")
14 T2=281.01//F
15 h1=1279.1
16 u1=h1-144*P1*v/778
17 uf=249.93
18 ufg=845.4
19 u2=uf+x2*ufg
20 Q=m*(u2-u1)
21 //results
22 printf("Final temperature = %.2f F",T2)
23 printf("\n Heat transferred = %d Btu",Q)

```

Scilab code Exa 13.2.a example 2

```

1  clc
2  //initialization of variables
3  T1=350+460 //R
4  v1=6 //cu ft/lb
5  m=1 //lb
6  R=53.34
7  v2=2*v1
8  cp=0.24
9  //calculations
10 P=R*T1/(v1*144)
11 W=P*144*(v2-v1)
12 T2=T1*v2/v1
13 Q=cp*(T2-T1)
14 h1=194.25
15 h2=401.09
16 dh=h2-h1
17 //results
18 printf("Final temperature = %d F",T2-460)
19 printf("\\n Enthalpy = %.2 f B/lb",dh)
20 printf("\\n Heat = %d B/lb",Q)

```

Scilab code Exa 13.2.b example 4

```

1  clc
2  //initialization of variables
3  T1=350+460 //R
4  v1=6 //cu ft/lb
5  m=1 //lb
6  R=53.34
7  v2=2*v1
8  cp=0.24
9  //calculations
10 disp("From steam tables,")
11 vg=3.342 //cu ft/lb
12 P1=77.5 //psia

```

```

13 P2=P1
14 h1=1204.8 //B/lb
15 v2=2*v1
16 T2=1106 //F
17 h2=1586.7 //B/lb
18 Q=h2-h1
19 W=P1*144*(v2-v1)
20 //results
21 printf("Final temperature = %d F",T2)
22 printf("\n Work = %d ft lb/lb",W)
23 printf("\n Heat = %.1f B/lb",Q)

```

Scilab code Exa 13.3.a example 5

```

1 clc
2 //initialization of variables
3 T1=400+460 //R
4 P1=50 //psia
5 ratio=1/10
6 R=53.34
7 //calculations
8 P2=P1/ratio
9 W=R*T1*log(ratio)
10 du=0
11 //results
12 printf("Final pressure = %d psia",P2)
13 printf("\n Work done = %.1f B/lb",W)
14 printf("\n Change in Internal energy = %d ",du)

```

Scilab code Exa 13.3.b example 6

```

1 clc
2 //initialization of variables

```

```

3 T1=400+460 //R
4 P1=50 //psia
5 ratio=1/10
6 R=53.34
7 v1=10.065 //cu ft/lb
8 vfg=1.8447 //cu ft/lb
9 vlg=1.8633 //cu ft/lb
10 //calculations
11 v2=v1*ratio
12 dx=(v2-vlg)/vfg
13 P2=247.3 //psia
14 disp("From steam tables,")
15 u2=773 //B/lb
16 u1=1141.6 //B/lb
17 du=u2-u1
18 s1=1.7349 //B/lb R
19 s2=1.082 //B/lb R
20 W=T1*(s2-s1) - du
21 //results
22 printf("Final pressure = %.1f psia",P2)
23 printf("\n Work done = %d B/lb",W)
24 printf("\n Change in Internal energy = %d B/lb ",du)

```

Scilab code Exa 13.4.a example 7

```

1 clc
2 //initialization of variables
3 P1=150 //psia
4 T1=400+460 //R
5 P2=15 //psia
6 g=1.4
7 R=53.34
8 //calculations
9 Tratio=(P2/P1)^((g-1)/g)
10 W=53.34*T1*(Tratio-1)/(1-g)

```



```

11 T2=T1*Tratio
12 v2=R*T2/(P2*144)
13 u1=147.50
14 Pr1=7.149
15 Pr2=Pr1*P2/P1
16 disp("From tables ,")
17 Pr=0.7149
18 T2=447 //R
19 u2=76.13 //B/lb
20 W=-(u2-u1)
21 v2=R*T2/(P2*144)
22 //results
23 printf("Final specific volume = %.1f cu ft/lb",v2)
24 printf("\n Work per pound of fluid = %.1f B/lb",W)

```

Scilab code Exa 13.4.b example 8

```

1 clc
2 //initialization of variables
3 disp("From Steam tables ,")
4 h1=1219.4
5 P1=150 //psia
6 v1=0.59733 //cu ft/lb
7 s1=1.5995 //B/lb R
8 //calculations
9 u1=h1-P1*v1
10 sg=1.7549
11 sfg=1.4415
12 s2=s1
13 dx=(sg-s2)/sfg
14 u2=981.3
15 W=u1-u2
16 v2=23.48
17 //results
18 printf("Final specific volume = %.2f cu ft/lb",v2)

```

```
19 printf("\n Work per pound of fluid = %.1f B/lb",W)
```

Scilab code Exa 13.5.a example 9

```
1 clc
2 //initialization of variables
3 P1=150 //psia
4 T1=400+460 //R
5 P2=15 //psia
6 n=1.15
7 cv=0.172
8 R=53.34
9 //calculations
10 v2=R*T1*(P1/P2)^(1/n) /(P1*144)
11 v1=R*T1/(P1*144)
12 T2=T1*P2*v2/(P1*v1)
13 Q=(cv - 0.458)*(T2-T1)
14 //results
15 printf("Final specific volume = %.1f cu ft/lb",v2)
16 printf("\n Final temperature = %d R",T2)
17 printf("\n Heat transferred = %.1f B/lb",Q)
```

Scilab code Exa 13.5.b example 10

```
1 clc
2 //initialization of variables
3 disp("From table 3,")
4 v1=3.223 //cu ft/lb
5 P1=150 //psia
6 T1=400+460 //R
7 P2=15 //psia
8 n=1.15
9 //calculations
```

```

10 v2=v1*(P1/P2)^(1/n)
11 T2=213 //F
12 W=144*(P2*v2-P1*v1)*0.00129/(1-n)
13 u1=1129.8 //B/lb
14 v2=23.9
15 vg=26.29
16 vfg=26.27
17 dx=(vg-v2)/vfg
18 u2=996.1
19 Q=(u2-u1)+W
20 //results
21 printf("Final specific volume = %.1f cu ft/lb",v2)
22 printf("\n Final temperature = %d F",T2)
23 printf("\n Heat transferred = %.1f B/lb",Q)

```

Scilab code Exa 13.6.a example 11

```

1 clc
2 //initialization of variables
3 v2=15.7 //cu ft/lb
4 T2=640 //R
5 cv=0.172
6 T1=400+460 //R
7 //calculations
8 du=cv*(T2-T1)
9 W=-du
10 //results
11 printf("Final specific volume = %.1f cu ft/lb",v2)
12 printf("\n Final temperature = %d ",T2)
13 printf("\n Work done = %.1f B/lb",W)

```

Scilab code Exa 13.6.b example 12

```
1 clc
2 //initialization of varaibles
3 disp("From steam tables,")
4 T2=213 //F
5 v2=23.9 //cu ft/lb
6 W=133.7 //B/lb
7 //results
8 printf("Final specific volume = %.1f cu ft/lb",v2)
9 printf("\\n Final temperature = %d ",T2)
10 printf("\\n Work done = %.1f B/lb",W)
```

Chapter 14

Vapor cycles rankine cycle

Scilab code Exa 14.1 example 1

```
1 clc
2 //initialization of variables
3 P1=200 //psia
4 T1=750+460 //R
5 P2=1 //psia
6 //calculations
7 disp("From steam tables ,")
8 h1=1399.2
9 h2=976
10 h3=69.70
11 v3=0.01614
12 dh3=v3*(P1-P2)*144/778
13 h4=dh3+h3
14 Q1=h1-h4
15 Wt=h1-h2
16 Wp=h4-h3
17 eta=(Wt-Wp)/Q1
18 w=2545/Wt
19 //results
20 printf("Heat supplied = %d B/lb",Q1+1)
21 printf("\n Turbine work = %d B/lb",Wt)
```

```
22 printf("\n Pump work = %.3f B/lb",Wp)
23 printf("\n Efficiency = %.3f",eta)
24 printf("\n Steam rate = %.2f lb steam per hr",w)
```

Scilab code Exa 14.2 example 2

```
1 clc
2 //initialization of variables
3 h1=1399.2 //B/lb
4 h2s=976 //B/lb
5 wt=8 //lb /hp hr
6 //calculations
7 Wt=2545/wt
8 etaT=Wt/(h1-h2s)
9 h2=h1-Wt
10 //results
11 printf("Engine efficiency = %.3f",etaT)
```

Scilab code Exa 14.3.a example 3

```
1 clc
2 //initialization of variables
3 P1=200 //psia
4 P2=1 //psia
5 e=0.7
6 //calculations
7 h1=1198.4
8 h2s=863.5
9 h3r=69.7
10 h4r=70.3
11 h3c=300.7
12 h4c=355.4
13 disp("For Rankine cycle , ")
```

```

14 Wtr=h1-h2s
15 Q1r=h1-h4r
16 Wpr=h4r-h3r
17 Wnetr=Wtr-Wpr
18 eta1=(Wtr-Wpr)/Q1r
19 wr=2545/Wtr
20 printf("Back work = %.1f B/lb",Wnetr)
21 printf("\n Efficiency = %.3f ",eta1)
22 printf("\n Steam rate = %.1f lb/hp hr",wr)
23 disp("For carnot cycle,")
24 Wtc=h1-h2s
25 Q1c=h1-h4c
26 Wpc=h4c-h3c
27 Wnetc=Wtc-Wpc
28 eta2=(Wtc-Wpc)/Q1c
29 wc=9.1
30 printf("Back work = %.1f B/lb",Wnetc)
31 printf("\n Efficiency = %.3f ",eta2)
32 printf("\n Steam rate = %.1f lb/hp hr",wc)

```

Scilab code Exa 14.3.b example 4

```

1 clc
2 //initialization of variables
3 P1=200 //psia
4 P2=1 //psia
5 e=0.7
6 //calculations
7 h1=1198.4
8 h2s=863.5
9 h3r=69.7
10 h4r=70.3
11 h3c=300.7
12 h4c=355.4
13 disp("For Rankine cycle with actual machines, ")

```

```
14 Wtr=e*(h1-h2s)
15 Q1r=(h1-h4r)
16 Wpr=(h4r-h3r)/e
17 Wnetr=Wtr-Wpr
18 eta1=(Wtr-Wpr)/Q1r
19 wr=2545/Wtr
20 printf("Back work = %.1f B/lb",Wnetr)
21 printf("\n Efficiency = %.3f ",eta1)
22 printf("\n Steam rate = %.1f lb/hp hr",wr)
23 disp("For carnot cycle,")
24 Wtc=e*(h1-h2s)
25 Q1c=h1-h4c
26 Wpc=(h4c-h3c)/e
27 Wnetc=Wtc-Wpc
28 eta2=(Wtc-Wpc)/Q1c
29 wc=16.2
30 printf("Back work = %.1f B/lb",Wnetc)
31 printf("\n Efficiency = %.3f ",eta2)
32 printf("\n Steam rate = %.1f lb/hp hr",wc)
```

Chapter 15

Vapor cycles More efficient cycles

Scilab code Exa 15.1 example 1

```
1 clc
2 //initialization of variables
3 e=0.85
4 disp("From Mollier chart and table 3,")
5 h1=1474.5 //B/lb
6 s1=1.5603 //B/lb R
7 h2s=1277.5 //B/lb
8 //calculations
9 h2=h1-e*(h1-h2s)
10 h3=1522.4 //B/lb
11 h4s=948 //B/lb
12 h4=h3-e*(h3-h4s)
13 h5=47.6 //B/lb
14 h6=53.5 //B/lb
15 h7s=840 //B/lb
16 h7=h1-e*(h1-h7s)
17 h8=1493.2 //B/lb
18 h9s=866 //B/lb
19 h9=h8-e*(h8-h9s)
```

```

20 h11=51.5 //B/lb
21 eta1=0.401
22 eta2=0.375
23 eta3=0.366
24 IE1=(eta1-eta2)/eta2
25 IE2=(eta1-eta3)/eta3
26 //results
27 printf("Improvement in efficiency = %d percent",IE1
    *100 +1)
28 printf("\nImprovement in efficiency in case 2= %.1f
    percent", IE2*100)

```

Scilab code Exa 15.2.a example 2

```

1 clc
2 //initialization of variables
3 disp("From mollier chart and table 3,")
4 h1=1371 //B/lb
5 h2s=1149 //B/lb
6 h3=118 //B/lb
7 e=0.9
8 disp(" Neglecting pump work,")
9 Q1=h1-h3
10 W=156 //B/lb
11 eta1=W/Q1
12 Q=h1-W-h3
13 UE=W+e*Q
14 fraction = UE/Q1
15 //results
16 printf("Fraction supplied = %.2f",fraction)

```

Scilab code Exa 15.2.b example 3

```
1 clc
2 //initialization of variables
3 disp("From mollier chart and table 3,")
4 h1=1371 //B/lb
5 h2s=1149 //B/lb
6 h3=118 //B/lb
7 e=0.23
8 e2=0.9
9 disp("Neglecting pump work,")
10 Q1=h1-h3
11 W=156 //B/lb
12 eta1=W/Q1
13 Q=h1-W-h3
14 We=W/e
15 UE=We+Q
16 UE1=W+e2*Q
17 Q2=Q+We
18 fraction = UE1/UE
19 //results
20 printf("Fraction supplied = %.2f",fraction)
```

Chapter 16

Gas cycles

Scilab code Exa 16.1.a example 1

```
1  clc
2  //initialization of variables
3  Pb=75 //psia
4  Pc=15 //psia
5  k=1.4
6  Td=550 //R
7  Tb=1700 //R
8  cp=0.24
9  //calculations
10 disp("Gas law solution")
11 Pratio=Pb/Pc
12 Ta=Td*(Pratio)^((k-1)/k)
13 Tc=Tb/(Pratio)^((k-1)/k)
14 Q1=cp*(Tb-Ta)
15 Q2=cp*(Tc-Td)
16 Wnet=Q1-Q2
17 eta=Wnet/Q1
18 eta2=1-Td/Ta
19 //results
20 printf("Efficiency in 1= %.3f",eta)
21 printf("\n Efficiency in 2 = %.2f",eta2)
```

```
22 printf("\n Work per pound of fluid = %d B/lb",Wnet)
```

Scilab code Exa 16.1.b example 2

```
1  clc
2  //initialization of variables
3  Pb=75 //psia
4  Pc=15 //psia
5  k=1.4
6  Td=550 //R
7  Tb=1700 //R
8  cp=0.24
9  //calculations
10 Prd=1.4779
11 hd=131.46 //B/lb
12 Prb=90.95
13 hb=422.59 //B/lb
14 Pratio=Pb/Pc
15 Pra=Pratio*(Prd)
16 Ta=868 //R
17 ha=208.41
18 Prc=Prb/Pratio
19 Tc=1113//R
20 hc=269.27
21 Q1=hb-ha
22 Q2=hc-hd
23 Wnet=Q1-Q2
24 eta=Wnet/Q1
25 //results
26 printf(" Efficiency = %.3f",eta)
27 printf("\n Work per pound of fluid = %.2f B/lb",Wnet
    )
```

Scilab code Exa 16.2 example 3

```
1  clc
2  //initialization of variables
3  e=0.75
4  Ta=870 //R
5  Tc=1075//R
6  cp=0.24
7  Td=550 //R
8  Tb=1700;
9  //calculations
10 Tdash=e*(Tc-Ta) +Ta
11 Tcdash=Tc+Ta-Tadash
12 Q1=cp*(Tb-Tadash)
13 Q2=cp*(Tcdash-Td)
14 Wnet=Q1-Q2
15 eta=Wnet/Q1
16 //results
17 printf("Net work done = %d B/lb",Wnet)
18 printf("\\n efficiency = %.2f ",eta)
```

Chapter 17

Fluid Flow Nozzles and Orifices

Scilab code Exa 17.1.a example 1

```
1 clc
2 //initialization of variables
3 w=1 //lb/sec
4 v2=36.4
5 h1=1279.1 //B/lb
6 h2=1091.7 //B/lb
7 V1=100 //fps
8 //calculations
9 a2=w*v2/(sqrt(2*32.2*778*(h1-h2) + V1^2)) //sq ft
10 a2=1.705 //sq in
11 //results
12 printf("Exit area = %.3f sq. in",a2)
```

Scilab code Exa 17.1.b example 2

```
1 clc
2 //initialization of variables
3 w = 1;
```

```

4 k=1.3
5 P=100 //psia
6 //calculations
7 Pratio=(2/(k+1))^(k/(k-1))
8 Pt=Pratio*P
9 disp("From table 3,")
10 ht=1221.5 //B/lb
11 vt=8.841 //cu ft/lb
12 at=w*vt/1700
13 //results
14 printf("Throat area = %.4f sq ft",at)

```

Scilab code Exa 17.2 example 2

```

1 clc
2 //initialization of variables
3 k=1.3
4 P=250 //psia
5 h0=1263.4 //B/lb
6 w=10000
7 cv=0.949
8 vts=3.415 //cu ft/lb
9 //calculations
10 Pratio=(2/(k+1))^(k/(k-1))
11 Pt=Pratio*P
12 hts=1208.2 //B/lb
13 h2s=891 //B/lb
14 Vts=sqrt(2*32.2*778*(h0-hts))
15 w=w/3600 //lb/sec
16 at=w*vts/(Vts)
17 V2=cv*sqrt(2*32.2*778*(h0-h2s))
18 etan=cv^2
19 h2=928 //B/lb
20 disp("From table 3,")
21 v2=276 //cu ft/lb

```



```

22 a2=w*v2/V2
23 a2s=0.17 //ft^2
24 Cw=0.98
25 at2=at/Cw
26 //results
27 printf("\n Throat area = %.5f ft^2",at)
28 printf("\n Exit area = %.3f ft^2",a2)
29 printf("\n For frictionless nozzle = %.3f ft^2",a2s)
30 printf("\n Changed throat area = %.5f ft^2 and exit
    area is unchanged",at2)

```

Scilab code Exa 17.3.a example 4

```

1  clc
2  //initialization of variables
3  w=1 //lb/sec
4  Pratio=0.53
5  k=1.4
6  T0=800 //R
7  cp=0.24
8  P0=150 //psia
9  P2=15 //psia
10 //calculations
11 Pt=Pratio*P0
12 Tratio=(Pratio)^((k-1)/k)
13 Tts=T0*Tratio
14 Vts=sqrt(2*32.2*778*cp*(T0-Tts))
15 vts=53.34*Tts/(Pt*144)
16 at=w*vts/(Vts)
17 T2s=T0*(Pt/P0)^((k-1)/k)
18 T2=460 //R
19 V2=sqrt(2*32.2*cp*778*(T0-T2))
20 v2=53.34*T2/(144*P2)
21 a2=w*v2/V2
22 //results

```

```

23 printf("Exit velocity = %d fps",Vts)
24 printf("\n Throat area = %.5 f ft^2",at)
25 printf("\n Exit area = %.5 f ft^2",a2)

```

Scilab code Exa 17.3.b example 5

```

1  clc
2  //initialization of variables
3  h0=191.81 //B/lb
4  Pr0=5.526
5  w=1 //lb/sec
6  Pratio=0.53
7  k=1.4
8  T0=800 //R
9  cp=0.24
10 P0=150 //psia
11 P2=15 //psia
12 Pt=79.5;
13 //calculations
14 Prt=Pratio*Pr0
15 disp("From keenan and kaye steam tables,")
16 Pr=2.929
17 Tts=668 //R
18 hts=159.9 //B/lb
19 Vts=sqrt(2*32.2*778*(h0-hts))
20 vts=53.34*Tts/(Pt*144)
21 at=w*vts/(Vts)
22 Pr2=P2*Pr0/P0
23 T2s=415 //R
24 h2s=99.13 //B/lb
25 h2=110.25 //B/lb
26 T2=462 //R
27 V2=sqrt(2*32.2*778*(h0-h2))
28 v2=53.34*T2/(144*P2)
29 a2=w*v2/V2

```

```
30 //results
31 printf("Exit velocity = %d fps",Vts)
32 printf("\n Throat area = %.5f ft^2",at)
33 printf("\n Exit area = %.5f ft^2",a2)
```

Chapter 18

Turbines

Scilab code Exa 18.1 example 1

```
1  clc
2  //initialization of variables
3  drop=50 //B/lb
4  cv=0.95
5  Vb=700 //fps
6  alpha=20 //degrees
7  beta=30 //degrees
8  Cb=0.95
9  //calculations
10 V1=cv*sqrt(2*32.2*778*drop)
11 y1=V1*cosd(alpha)
12 z1=V1*sind(alpha)
13 y1R=y1-Vb
14 V1R=sqrt(y1R^2 + z1^2)
15 V2R=Cb*V1R
16 y2R=-V2R*cosd(beta)
17 z2=V2R*sind(beta)
18 Wx=(y1R-y2R)*Vb/32.2
19 Fa=(z1-z2)/32.2
20 Vc=1582.77
21 etanb=Wx/(Vc^2 / (2*32.2))
```

```
22 //results
23 printf("Work per pound of fluid = %d ft lbf/lbm",Wx)
24 printf("\n Axial thrust = %.1f lbf/lbm/sec",Fa)
25 printf("\n Nozzle bucket efficiency = %.2f",etanb)
```

Scilab code Exa 18.2 example 2

```
1 clc
2 //initialization of variables
3 ha=1187.2 //B/lb
4 sa=1.6026 //B/lb R
5 h3s=895 //B/lb
6 h1s=1090 //B/lb
7 p1=28 //psia
8 h2s=993 //B/lb
9 p2=6.2 //psia
10 n=0.65
11 //calculations
12 disp("From Table 3,")
13 h1=ha-n*(ha-h1s)
14 s1=1.65 //B/lb R
15 h2dash=1024 //B/lb
16 h2=h1-n*(h1-h2dash)
17 s2=1.706 //B/lb R
18 h3dash=953 //B/lb
19 h3=h2-n*(h2-h3dash)
20 etaT=(ha-h3)/(ha-h3s)
21 reheat=etaT/n
22 //results
23 printf("Internal efficiency = %.3f",etaT)
24 printf("\n Reheat factor = %.2f",reheat)
```

Chapter 19

Reciprocating expanders and compressors

Scilab code Exa 19.1 example 1

```
1 clc
2 //initialization of variables
3 disp("From tables ,")
4 h1=1185.3 //B/lb
5 v1=4.896 //cu ft/lb
6 v2=23.66 //cu ft/lb
7 h2=1054.3 //B/lb
8 Pd1=1 //cu ft
9 Pd2=0.98 //cu ft
10 N=300 //rpm
11 //calculations
12 Wx=h1-h2
13 Pd=Pd1+Pd2
14 Cl=0.05
15 mf=Pd*(1-Cl*(v2/v1 - 1))/v2
16 P=Wx*mf*N/(2545/60)
17 mep=P*33000/(N*Pd)
18 //results
19 printf("Horsepower output = %.3 f hp" ,P)
```

```
20 printf("\n Mean effective pressure = %d psf",mep)
21 //The answers in the book are a bit different due to
    round off error.
```

Scilab code Exa 19.2 example 2

```
1  clc
2  //initialization of variables
3  R=53.34
4  T1=540 //R
5  P1=15 //psia
6  T2=720 //R
7  P2=60 //psia
8  PD=150 //cu ft/min
9  p1=0.03
10 p2=0.06
11 //calculations
12 v1=R*T1/(P1*144)
13 vratio=T1*P2/(P1*T2)
14 Nmf=PD*(1-p1*(vratio-1))/v1
15 Nmf2=PD*(1-p2*(vratio-1))/v1
16 //results
17 printf("For clearance of 3 percent , Mass per min = %
    .1 f lb/min",Nmf)
18 printf("\n For clearance of 6 percent , Mass per min
    = %.1 f lb/min",Nmf2)
```

Chapter 21

Gas compression

Scilab code Exa 21.1 example 1

```
1  clc
2  //initialization of variables
3  R=53.34
4  T1=540 //R
5  n=1.4
6  g=n
7  n2=1.3
8  P2=90 //psia
9  P1=15 //psia
10 cv=0.171
11 //calculations
12 pv=R*T1
13 Wk=n*R*T1*((P2/P1)^((g-1)/g) -1) /(n-1)
14 Wn=n2*R*T1*((P2/P1)^((n2-1)/n2) -1) /(n2-1)
15 Wt=R*T1*log(P2/P1)
16 Q=cv*(n-n2)*778*T1*((P2/P1)^((n2-1)/n2) -1) /(1-n2)
17 //results
18 printf("\n Work in case 1 = %d ft lb/lb",Wk)
19 printf("\n Work in case 2 = %d ft lb/lb",Wn)
20 printf("\n Work in case 3 = %d ft lb/lb",Wt)
21 printf("\n Heat transferred = %.1f B/lb",Q*0.001305)
```

Scilab code Exa 21.2 example 2

```
1 clc
2 //initialization of variables
3 R=53.34
4 T1=540 //R
5 n=1.4
6 g=n
7 n2=1.3
8 P2=90 //psia
9 P1=15 //psia
10 cv=0.171
11 //calculations
12 pv=R*T1
13 Wk=n*R*T1*((P2/P1)^((g-1)/g) -1) /(n-1)
14 Wn=n2*R*T1*((P2/P1)^((n2-1)/n2) -1) /(n2-1)
15 Wt=R*T1*log(P2/P1)
16 eta1=Wt/Wn
17 eta2=Wk/Wn
18 //results
19 printf("Adiabatic efficiency = %.2f",eta2)
20 printf("\n Isothermal efficiency = %.2f",eta1)
```

Scilab code Exa 21.3 example 3

```
1 clc
2 //initialization of variables
3 R=53.34
4 T1=540 //R
5 n=1.4
6 g=n
```

```

7 n2=1.3
8 P2=90 //psia
9 P1=15 //psia
10 cv=0.171
11 cp=0.24;
12 eta=0.95
13 //calculations
14 pv=R*T1
15 Wk=n*R*T1*((P2/P1)^((g-1)/g) -1)/(n-1)
16 Wn=n2*R*T1*((P2/P1)^((n2-1)/n2) -1)/(n2-1)
17 Wt=R*T1*log(P2/P1)
18 Wx=-Wk/eta
19 dh=cp*T1*(1.52 - 1)
20 Q=dh+Wx/778
21 //results
22 printf("Heat transferred = %.1f B/lb",Q)

```

Scilab code Exa 21.4 example 4

```

1 clc
2 //initialization of variables
3 n=1.3
4 P1=15 //psia
5 P2=75 //psia
6 eta=0.5
7 eta2=0
8 //calculations
9 Pr=(P2/P1)^(1/n)
10 C1=(1-eta)/(Pr-1)
11 C12=(1-eta2)/(Pr-1)
12 //results
13 printf("For volumetric efficiency to be 0.5,
         Clearance = %.3f",C1)
14 printf("\n For volumetric efficiency to be 0,
         Clearance = %.3f",C12)

```

Scilab code Exa 21.5 example 5

```
1 clc
2 //initialization of variables
3 P1=5 //psia
4 P2=83.5 //psia
5 n=1.25
6 per=0.03
7 //calculations
8 nv1=1- per*((P2/P1)^(1/n) -1)
9 nv2=1-per*((sqrt(P2/P1))^(1/n) -1)
10 //results
11 printf("For single stage machine = %.3f",nv1)
12 printf("\\n For Two stage machine = %.3f",nv2)
```

Chapter 22

Combustion Processes First law analysis

Scilab code Exa 22.5 example 1

```
1  clc
2  //initialization of variables
3  m0=1.33
4  C0=0.155
5  mC=3.67
6  CC=0.165
7  t2=1000 //F
8  tb=68 //F
9  t1=300 //F
10 mC2=1
11 CC2=0.17
12 mO2=4
13 CO2=0.155
14 H=-14087 //B/lb
15 //calculations
16 dE2=m0*C0*(t2-tb) + mC*CC*(t2-tb)
17 dE1=mO2*CO2*(tb-t1) + mC2*CC2*(tb-t1)
18 Q=dE2+dE1+H
19 //results
```

```
20 printf("Heat transfer from the system = %d Btu",Q)
```

Scilab code Exa 22.6 example 2

```
1 clc
2 //initialization of variables
3 H1=17889 //Cal/g
4 H2=-94052 //Cal/g
5 H3=2* -68317 //Cal/g
6 //calculations
7 x=H1+H2+H3
8 //results
9 printf("Constant pressure heating value of methane =
    %d cal/gm formula wt.",x)
```

Scilab code Exa 22.7 example 3

```
1 clc
2 //initialization of variables
3 HV=4344 //B/lb
4 xC=56 //lb
5 R=1.986
6 T=530 //R
7 MC=56 //g/mol
8 //calculations
9 HR=xC*HV
10 Eb=-HR -R*T*(2-3)
11 HV=-Eb/MC
12 //results
13 printf("COntant volume heating value = %d B/lb ",HV
    )
```

Scilab code Exa 22.8 example 4

```
1 clc
2 //initialization of variables
3 dH2=14087 //B/lb
4 xc=3.67 //lb
5 xN=8.78 //lb
6 tb=100 //F
7 //calculations
8 dt2=dH2/(xc*0.196 + xN*0.248)
9 t2=dt2+tb
10 //results
11 printf("products temperature = %d F",t2)
```

Scilab code Exa 22.9 example 5

```
1 clc
2 //initialization of variables
3 Heat=14087 //Btu/lb
4 x1=0.9 //lb
5 x2=0.05 //lb
6 x3=0.05 //lb
7 Heat2=3952 //Btu/lb
8 //calculations
9 h1=x1*Heat
10 h2=x2*Heat2
11 e=(h1+h2)/Heat
12 //results
13 printf("Efficiency = %.2f",e)
```

Scilab code Exa 22.10 example 6

```
1 clc
2 //initialization of variables
3 disp("From data and steam tables ,")
4 Q=10240000 //B/hr
5 w=700 //lb/hr
6 h=19500 //B/lb
7 //calculations
8 HV=w*h
9 e=Q/HV
10 //results
11 printf(" Efficiency = %.2f" ,e)
```

Chapter 23

Internal combustion power plants

Scilab code Exa 23.1 example 1

```
1  clc
2  //initialization of variables
3  disp("from chart")
4  T6=2600 //R
5  mratio=0.05
6  V6d=82 //cu ft
7  E6d=465 //Btu
8  H6d=655 //Btu
9  T6d=2480 //R
10 Hs=58 //Btu
11 LHV=19256
12 //calculations
13 H1=mratio*H6d + (1-mratio)*Hs
14 dV=22-3.67
15 PD=0.12
16 Work=446*PD/dV
17 pm=Work*778/(144*PD)
18 eta=446/((1-mratio)*(LHV*0.0665))
19 //results
```



```

20 printf(" Efficiency = %.3f",eta)
21 printf("\n Mean effective pressure = %d psi",pm)
22 printf("\n Work per machine cycle = %.2f Btu",Work)

```

Scilab code Exa 23.2 example 2

```

1  clc
2  //initialization of variables
3  f=0.03
4  T6=1500 //R
5  disp("from air tables,")
6  hi=131.46 //B/lb
7  h6=381 //B/lb
8  vratio=1/15
9  v1r=120.7
10 P1=15 //psi
11 T1=580 //R
12 x=0.5
13 Tb=520 //R
14 H=18500 //B/lb
15 mh=0.0345
16 m3=1.065
17 //calculations
18 h1=f*h6+(1-f)*hi
19 v2r=v1r*vratio
20 T2=1615 //R
21 u2=289.05 //B/lb
22 P2=T2*1/vratio *P1/T1
23 theo=0.069 //lb/lb of air
24 m=theo*x
25 h3B=0.242*Tb
26 m3=1+0.03+0.0345
27 h3=(638+284)/1.065 +h3B
28 T3=3520 //R
29 P3=626 //psi

```

```

30 v3=53.34*T3/(P3*144)
31 v3p=v3*m3
32 v1=53.35*T1/(144*P1)
33 v2=14.7/P1
34 m1=1.03
35 h3=992
36 h4=531
37 T3=3520 //R
38 T4=2030 //R
39 W12=m1*(98.9-289.05)
40 W23=P2*(v3p-v2)*144/778
41 W34=m3*(h3-h4-53.4*(T3-T4)/778)
42 W=W12+W23+W34
43 eta=W/(mh*H)
44 //results
45 printf("Efficiency = %.3f",eta)

```

Scilab code Exa 23.3 example 3

```

1 clc
2 //initialization of variables
3 disp("Using air tables,")
4 h1=124.27
5 pr1=1.2147
6 p2byp1=6
7 p1=15
8 p4=15
9 eta=0.8
10 //calculations
11 pr2=p2byp1*pr1
12 h2s=197.5
13 h2=h1+(h2s-h1)/eta
14 h2B=124.3
15 dhB=-18500 //B/lb
16 dh2=h2B-h2

```

```

17 T3=1910 //R
18 h3=479.85
19 pr3=144.53
20 h3B=h2B
21 dh3=h3-h3B
22 wratio=(-dh3-dh2)/(dh3+dhB)
23 pr4=28.91
24 h4s=306.9
25 h4=h3-eta*(h3-h4s)
26 Wt=(1+wratio)*(h3-h4)
27 Wc=(h2-h2B)
28 Wnet=Wt-Wc
29 E=Wnet/(wratio*-dhB)
30 rate=2545/Wnet
31 BWratio=Wc/Wnet
32 //results
33 printf(" Efficiency = %.3f",E)
34 printf("\n Air rate = %.1f lb air/hp hr",rate)
35 printf("\n Back work ratio = %.2f",BWratio)

```

Scilab code Exa 23.4 example 4

```

1 clc
2 //initialization of variables
3 V1=587 //fps
4 etaD=0.9
5 etaC=0.8
6 h1=114.69
7 P1=10 //psia
8 P3=626;
9 P6=P1
10 dhB=-19100 //B/lb
11 T1=480 //R
12 //calculations
13 h2s=etaD*V1^2 /((778*2*32.2) +h1

```

```

14 disp("From tables ,")
15 Pr2s=1.104
16 Pr1=0.9182
17 P2=P1*Pr2s/Pr1
18 h2=h1+(h2s-h1)/etaD
19 T2=509 //R
20 Pr2=1.127
21 Pr3s=Pr2*P3/P2
22 Pr3s=6.76
23 h3s=203.2
24 h3=(h3s-h2)/etaC +h2
25 T3=930 //R
26 P3=6*P2
27 T4=2160 //R
28 h4=549.35
29 Pr4=238
30 h4B=126.66
31 dh4=422.7
32 h3B=h4B
33 dh3=h3-h3B
34 cp=0.5
35 Ta=480 //R
36 Tb=530 //R
37 dhf=cp*(Tb-Ta)
38 wratio=(-dh4+dh3)/(dh4+dhf+dhB)
39 h5s=425.3
40 Pr5s=93.1
41 P5=27.6
42 T5=1801 //R
43 Pr5=114.28
44 Pr6s=Pr5*P6/P5
45 h5=450
46 h6=351
47 V6=sqrt(2*32.2*778*(h5-h6))
48 SI=((1+wratio)*V6 -V1)/(32.2)
49 v1=53.34*T1/(P1*144)
50 wa=V1/v1
51 thrust = wa*SI

```

```
52 SC=wa*0.0174*3600/1840
53 eff=2545/(SC*-dhB)
54 //results
55 printf(" Specific impulse = %.1f lb/lb per sec of air
        ",SI)
56 printf("\n Thrust = %d lb",thrust)
57 printf("\n Efficiency = %.3f",eff)
```

Chapter 24

Refrigeration

Scilab code Exa 24.1 example 1

```
1  clc
2  //initialization of variables
3  disp("From tables ,")
4  h1=611.8 //B/lb
5  h2=704.4 //B/lb
6  h3=127.4 //B/lb
7  h4=h3
8  T2=460 //R
9  T1=76+460 //R
10 W=10000 //B/hr
11 e=0.7
12 //calculations
13 Qe=h1-h4
14 Wc=h2-h1
15 CP=Qe/Wc
16 CP2=T2/(T1-T2)
17 w=W/(Qe*60)
18 v1=9.116 //cu ft/lb
19 PD=w*v1/(e)
20 //results
21 printf("Coefficient of performance in case 1 = %.2f")
```

```
    ,CP)
22 printf("\n Coefficient of performance in case 2 = %
    .2f",CP2)
23 printf("\n Piston displacement = %.2f cu ft/min",PD)
```

Chapter 25

Air water vapor mixtures

Scilab code Exa 25.1 example 1

```
1 clc
2 //initialization of variables
3 Pg=0.4298 //steam tables psi
4 phi=0.5
5 P=14.7 //psi
6 //calculations
7 pw=phi*Pg
8 Pa=P-pw
9 gamma=0.622*pw/Pa
10 T=55 //F from dew point tables
11 //results
12 printf(" Specific humidity = %.5f lb water/lb dry air
13        ",gamma)
13 printf("\n Dew temperature = %d F",T)
```

Scilab code Exa 25.2 example 2

```
1 clc
```



```

2 //initialization of variables
3 disp("From psychrometric chart ,")
4 hgdp=1061.8
5 cpw=0.44
6 tdb=72 //F
7 cp=0.24
8 g=0.0071
9 //calculations
10 rh=0.42
11 sp=g
12 tdp=58 //F
13 hw=hgdp+cpw*tdb
14 h=cp*tdb+g*hw
15 //results
16 printf("Enthalpy = %.2f B/lb dry air",h)
17 printf("\n relative humidity = %.2f ",rh)
18 printf("\n specific humidity = %.2f ",sp)
19 printf("\n Dew point temperature = %d F",tdp)

```

Scilab code Exa 25.3 example 3

```

1 clc
2 //initialization of variables
3 disp("From the psychrometric chart ,")
4 ha=12.9 //B/lb
5 g1=0.0032 //lb water/ lb dry air
6 g2=0.0078 //lb water/ lb dry air
7 h1=13 //B/lb
8 hd=25.33 //B/lb
9 p=14.7 //psia
10 phi=0.6
11 cp=0.24
12 t2=70 //F
13 //calculations
14 w1=g2-g1

```

```

15 Q=hd-ha-w1*h1
16 pg=0.1217 //psia
17 pa=p-pg
18 G1=0.622*pg*phi/pa
19 G2=0.00788
20 w12=G2-G1
21 t1=40 //F
22 hw1=1061.8 + 0.44*t1
23 hw2=1092.6 //B/lb
24 Q2=cp*(t2-t1) + G2*hw2 -G1*hw1 - w12*h1
25 //results
26 printf("Method 1")
27 printf("\n Water to be supplied = %.4f lb/lb of dry
    air",w1)
28 printf("\n heat supplied = %.1f B/lb of dry air",Q)
29 printf("\n Method 2")
30 printf("\n Water to be supplied = %.5f lb/lb of dry
    air",w12)
31 printf("\n heat supplied = %.1f B/lb of dry air",Q2)

```

Scilab code Exa 25.4 example 4

```

1 clc
2 //initialization of variables
3 disp("From psychrometric charts,")
4 e=0.7
5 phi=0.5
6 g1=0.0131 //lb water/lb dry air
7 h1=32.36 //B/lb of dry air
8 g3=0.0073
9 h3=24.26
10 pg=0.3390
11 T3=528 //R
12 V3=1000
13 Rw=85.8

```

```

14 // calculations
15 pw3=phi*pg
16 ww3=pw3*144*V3/(Rw*T3)
17 wa3=ww3/g3
18 wa1=phi*wa3
19 wa2=phi*wa3
20 ww1=g1*wa1
21 ww2=ww3-ww1
22 g2=ww2/wa2
23 h2=(wa3*h3-wa1*h1)/wa2
24 tdb=61 //F
25 // results
26 printf(" Air supplied = %.3f lb/min",ww2)
27 printf("\n temperature = %d F",tdb)
28 printf("\n Humidity = %.5f lb water/lb dry air",g2)

```

Scilab code Exa 25.5 example 5

```

1 clc
2 //initialization of variables
3 disp("From psychrometric charts,")
4 g1=0.0131 //lb water/lb dry air
5 g2=0.0093 //lb water/lb dry air
6 h1=32.36 //B/lb dry air
7 h2=27.03
8 hd2=23.4 //B/lb dry air
9 hf=23.4 //B/lb dry air
10 hw1=1094.5
11 // calculations
12 tdp=55.3 //F
13 wratio=g1-g2
14 Qc=hd2-h1+wratio*hf
15 Qh=h2-hd2
16 Heat=wratio*(hw1-hf)
17 frac=-Heat/Qc

```

```
18 //results
19 printf("Cooling temperature = %.1f F",tdp)
20 printf("\n heat transfer = %.2f B/lb dry air",Heat)
21 printf("\n Fraction of heat removed = %.2f",frac)
```
