

Scilab Textbook Companion for
Introduction To Thermodynamics And Heat
Transfer
by D. A. Mooney¹

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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 2

Work

Scilab code Exa 2.1 chapter 2 example 1

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

Scilab code Exa 2.2 chapter 2 example 2

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



```

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

```

Scilab code Exa 2.3 chapter 2 example 3

```

1 clc
2 //initialisation of variables
3 r= 11 //in
4 l= 15 //in
5 A= 1.6 //in
6 l1= 2.4 //in
7 //CALCULATIONS
8 a= %pi*r^2/4
9 L= l/12
10 Pm= (A/l1)*80
11 W= a*L*Pm
12 //RESULTS
13 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

```
1  clc
2  //initialisation of variables
3  T2w= 100 //F
4  T1w= 75  //F
5  cw= 1   //Btu/lb F
6  T2i= 100 //F
7  T1i= 500 //F
8  ci= 0.12 //Btu/lb F
9  mi= 1
10 //CALCULATIONS
11 Mw= -mi*ci*(T2i-T1i)/(cw*(T2w-T1w))
12 //RESULTS
13 printf ('Pounds of water needed per pound of iron= %
        .2f lb water/lb iron ',Mw)
```

Scilab code Exa 3.2 chapter 3 example 2

```
1  clc
```

```

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

```

Scilab code Exa 3.3 chapter 3 example 3

```

1 clc
2 //initialisation of variables
3 m= 10 //lb
4 cp= 0.180 //Btu/lb F
5 cp1= 0.235 //Btu/lb F
6 L= 15.8 //btu/lb
7 L1= 120 //btu/lb
8 T1= 70 //F
9 T2= 235 //F
10 T3= 832 //F
11 //CALCULATIONS
12 Qa= m*cp*(T2-T1)
13 Qb= m*L
14 Qc= m*cp1*(T3-T2)
15 Qd= m*L1
16 Q= Qa+Qb+Qc+Qd
17 //RESULTS
18 printf ('Heat required= %.f Btu',Q)

```

Scilab code Exa 3.4 chapter 3 example 4

```
1  clc
2  //initialisation of variables
3  m= 40 //lb
4  m1= 10 //lb
5  cp= 1.00 //Btu/lb F
6  cp1= 0.501 //Btu/lb F
7  cp2= 0.092 //Btu/lb F
8  L= 143.3 //btu/lb
9  L1= 120 //btu/lb
10 T1= 22 //F
11 T2= 32 //F
12 T3= 40 //F
13 T4= 70 //F
14 //CALCULATIONS
15 Qa= cp1*(T2-T1)
16 Qb= L
17 Qc= cp*(T3-T2)
18 Qd= m*cp*(T3-T4)
19 mi= -Qd/(Qa+Qb+Qc)
20 Qe= m1*cp2*(T3-T4)
21 mi1= -Qe/(Qa+Qb+Qc)
22 //RESULTS
23 printf ('Ice weight= %.2f lb of ice ',mi)
24 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

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

Scilab code Exa 5.2 chapter 5 example 2

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

```

5 cv= 1.2 //Btu/lb F
6 Q= 34 //Btu
7 //CALCULATIONS
8 U= m*cv*T2
9 W= Q-U
10 //RESULTS
11 printf ('Change in internal enengy = %.f Btu',W)

```

Scilab code Exa 5.3 chapter 5 example 3

```

1 clc
2 //initialisation of variables
3 p= 500 //psia
4 V2= 0.9278 //cu ft/lb
5 V1= 0.0197 //cu ft/lb
6 h= 1204.4 //Btu/lb
7 h1= 449.4 //Btu/lb
8 //CALCULATIONS
9 W= p*144*(V2-V1)
10 U= h-h1-(W/778)
11 //RESULTS
12 printf ('Change in internal enengy = %.1f Btu',U)

```

Scilab code Exa 5.4 chapter 5 example 4

```

1 clc
2 //initialisation of variables
3 m= 3 //lb
4 V1= 6 //cu ft
5 p1= 75. //psia
6 p2= 15 //psia
7 n= 1.2
8 Q1= 30 //Btu

```

```
9 //CALCULATIONS
10 V2= V1*(p1/p2)^(1/n)
11 disp(V2)
12 U= (m/3)*(0.480*p2*V2+35-0.480*p1*V1-35)
13 W= (p2*V2-p1*V1)/(1-n)
14 Q= U+W
15 W1= Q1-U
16 //RESULTS
17 printf ('Change in internal energy = %.1f Btu',U)
18 printf ('\n Work done = %.f Btu',W)
19 printf ('\n Heat generated = %.f Btu',Q)
20 printf ('\n Work done = %.f Btu',W1)
21 //The answers given in the textbook are wrong.please
    calculate them personally.
```

Chapter 6

Flow Processes First law analysis

Scilab code Exa 6.1 Chapter 6 example 1

```
1  clc
2  //initialisation of variables
3  u1= 1111.9 //Btu/lb
4  p= 170 //psia
5  v1= 2.675 //cu ft/lb
6  V1= 6000 //ft/min
7  g0= 32.2 //ft/sec^2
8  g= 32.2 //ft/sec^2
9  z= 10 //ft
10 Q= 1000//Btu/hr
11 u2= 914.6 //Btu/lb
12 p1= 3 //psia
13 v2= 100.9 //cu ft/lb
14 V2= 300 //ft/sec
15 g0= 32.2 //ft/sec^2
16 g= 32.2 //ft/sec^2
17 z1= 0 //ft
18 //CALCULATIONS
19 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
20 //RESULTS
21 printf ('Poweroutput = %.f hp',Wx*0.000393014779)
22 //It is the conversion factor from btu/hr to hp

```

Scilab code Exa 6.2 chapter 6 example 2

```

1 clc
2 //initialisation of variables
3 w1= 500 //lb/min
4 h1= 132.9 //Btu/lb
5 h2= 1150 //Btu/lb
6 h3= 180 //Btu/lb
7 //CALCULATIONS
8 w2= w1*(h3-h1)*60/(h2-h3)
9 //RESULTS
10 printf ('Steam supplied to the hater = %.f lb/hr',w2
    )

```

Scilab code Exa 6.3 chapter 6 example 3

```

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

```

```
12 w=A1*V1/v1
13 //RESULTS
14 printf ('Average velocity at section1 = %.f fps ',V1)
15 printf (' \n Average velocity at section2 = %.f 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 Chapter 8 example 1

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

Scilab code Exa 8.2 chapter 8 example 2

```
1 clc
2 //initialisation of variables
3 T1= 1050 //F
```

```

4 T2= 90 //F
5 //CALCULATIONS
6 n= (T1-T2)/(T1+460)
7 n1= n*100
8 //RESULTS
9 printf ('Maximum thermal efficiency = %.f percent ',
        n1)

```

Scilab code Exa 8.3 chapter 8 example 3

```

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

```

Scilab code Exa 8.4 chapter 8 example 4

```

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

```

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

Scilab code Exa 8.5 chapter 8 example 5

```
1  clc
2  //initialisation of variables
3  Q= 826 //Btu/lb
4  T= 400 //F
5  T1= 1000 //F
6  T2= 2000 //F
7  //CALCULATIONS
8  Sw= Q/(T+460)
9  Sg= (Q/T1)*(log(T1+460)-log(T2+460))
10 S= Sw+Sg
11 //RESULTS
12 printf ('Total Entropy change = %.3f Btu/R',S)
```

Scilab code Exa 8.6 chapter 8 example 6

```
1  clc
2  //initialisation of variables
3  Q= 826 //Btu/lb
4  T= 400 //F
5  T1= 1000 //F
6  T2= 2000 //F
7  T3= 80 //F
8  //CALCULATIONS
9  Sw= Q/(T+460)
10 Sg= (Q/T1)*(log(T1+460)-log(T2+460))
11 S= Sw+Sg
12 Q1= (T3+460)*S
```

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

Chapter 10

Tabulated properties Steam Tables

Scilab code Exa 10.1 Chapter 10 example 1

```
1 clc
2 //initialisation of variables
3 p= 100//psia
4 vg= 4.432 //cu ft/lb
5 vf= 0.01744 //cu ft/lb
6 T= 327.8 //F
7 sfg= 1.1286 //Bu/lb R
8 //CALCULATIONS
9 Q=(T+460)*sfg
10 //RESULTS
11 printf ('Heat of vaourisation= %.f Btu/lb ',Q)
```

Scilab code Exa 10.2 chapter 10 example 2

```
1 clc
2 //initialisation of variables
```

```

3 S= 1.6315 //Btu/lb R
4 //CALCULATIONS
5 P= 70 //psia
6 t= 302.92 //F
7 h= 1180.6 //Btu/lb
8 //RESULTS
9 printf ('Pressure= %.2f Psia ',P)
10 printf (' \n Temperature = %.2f F ',t)
11 printf (' \n Enthalpy= %.1f Btu/lb ',h)

```

Scilab code Exa 10.3 chapter 10 example 3

```

1 clc
2 //initialisation of variables
3 T= 250 //F
4 hg= 1164.0 //Btu/lb
5 P= 29.825 //Psia
6 Vg= 13.821 //cu ft/lb
7 //CALCULATIONS
8 ug= hg-(P*Vg*144/778)
9 //RESULTS
10 printf ('Internal energy= %.1f Btu/lb ',ug)

```

Scilab code Exa 10.4 chapter 10 example 4

```

1 clc
2 //initialisation of variables
3 P= 100 //psia
4 n= 40
5 vf= 0.01774 //cu ft/lb
6 vg= 4.432 //cu ft/lb
7 hf= 298.4 //Btu/lb
8 hfg= 888.8 //Btu/lb

```



```

9  sg= 1.6026 //Btu/lb R
10 sfg= 1.1286 //Btu/lb R
11 //CALCULATIONS
12 vx= (n/100)*vf+(1-(n/100))*vg
13 hx= hf+(1-(n/100))*hfg
14 sx= sg-(n/100)*sfg
15 //RESULTS
16 printf ('Volume= %.2f cu ft/lb ',vx)
17 printf (' \n Entropy = %.2f Btu/lb R',sx)
18 printf (' \n Enthalpy= %.1f Btu/lb ',hx)

```

Scilab code Exa 10.5 chapter 10 example 5

```

1  clc
2  //initialisation of variables
3  P= 100 //psia
4  n= 0.97
5  hf= 298.4 //Btu/lb
6  hfg= 888.8 //Btu/lb
7  hg= 1187.2 //Btu/lb
8  //CALCULATIONS
9  hx= hf+n*hfg
10 hx1= hg-(1-n)*hfg
11 //RESULTS
12 printf ('Enthalpy= %.f Btu/lb ',hx)
13 printf (' \n Precise Enthalpy= %.1f Btu/lb ',hx1)

```

Scilab code Exa 10.6 chapter 10 example 6

```

1  clc
2  //initialisation of variables
3  P= 15 //psia
4  S= 1.7050 //Btu/lb R

```

```

5 sg= 1.7549 //btu/lb R
6 sfg= 1.4415 //Bru/lb R
7 hg= 1150.8 //btu/lb
8 hfg= 969.7 //Btu/lb
9 vg= 26.29 //cu ft/lb
10 vfg= 26.27 //cu ft/lb
11 //CALCULATIONS
12 n= (sg-sx)/sfg
13 sx= sg-n*sfg
14 hx= hg-n*hfg
15 vx= vg-n*vfg
16 //RESULTS
17 printf ( 'Volume= %.2f cu ft/lb ',vx)
18 printf ( ' \n Entropy = %.2f Btu/lb R',sx)
19 printf ( ' \n Enthalpy= %.1f Btu/lb ',hx)

```

Scilab code Exa 10.10 chapter 10 example 10

```

1  clc
2  //initialisation of variables
3  T= 100 //F
4  P= 1000 //psia
5  dv= -5.1*10^-5 //cu ft/lb
6  dh= 2.70 //Btu/lb
7  vf= 0.01613 //cu ft/lb
8  hf= 67.97 //Btu/lb
9  //CALCULATIONS
10 h= dh+hf
11 v= dv+vf
12 //RESULTS
13 printf ( 'Volume= %.5f cu ft/lb ',v)
14 printf ( ' \n Enthalpy= %.2f Btu/lb ',h)

```

Scilab code Exa 10.11 chapter 10 example 11

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

Chapter 11

Properties of Gases

Scilab code Exa 11.1 Chapter 11 example 1

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

Scilab code Exa 11.2 chapter 11 example 2

```
1 clc
2 //initialisation of variables
```

```

3 R= 48.3 //ft lb/lb R
4 T= 100 //F
5 T1= 500 //F
6 T2= 1500 //F
7 k= 1.4
8 k1= 1.36
9 k2= 1.31
10 //CALCULATIONS
11 dc= R/778
12 cp= (k/(k-1))*dc
13 cv= cp/k
14 cp1= (k1/(k1-1))*dc
15 cv1= cp/k1
16 cp2= (k2/(k2-1))*dc
17 cv2= cp2/k2
18 //RESULTS
19 printf ('cp= %.3f Btu/lb R',cp)
20 printf ('\n cv= %.3f Btu/lb R',cv)
21 printf ('\n cp1= %.3f Btu/lb R',cp1)
22 printf ('\n cv1= %.3f Btu/lb R',cv1)
23 printf ('\n cp2= %.3f Btu/lb R',cp2)
24 printf ('\n cv2= %.3f Btu/lb R',cv2)

```

Scilab code Exa 11.4 chapter 11 example 4

```

1 clc
2 //initialisation of variables
3 P= 10 //psia
4 P1= 100 //psia
5 T= 140 //F
6 k= 1.4
7 R= 55.16 //ft lb/lb R
8 //CALCULATIONS
9 dh= (k*R*(T+460)/(k-1))*((P/P1)^((k-1)/k)-1)
      *(72/56000)

```

```

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

```

Scilab code Exa 11.5 chapter 11 example 5

```

1  clc
2  //initialisation of variables
3  P= 100 //psia
4  P1= 15 //psia
5  T= 2000 //F
6  k= 1.4
7  R= 53.34 //ft lb/lb R
8  cp= 0.240 //Btu/lb R
9  //CALCULATIONS
10 v1= (R*(T+460)/(P*144))*(P/P1)^(1/k)
11 disp(v1)
12 T1= (T+460)*(P1*v1/(P*(R*(T+460)/(P*144))))
13 dh= cp*(T1-T)
14 dv= v1-(R*(T+460)/(P*144))
15 disp('case 1')
16 printf ('change in volume = %.2 f', dv)
17 disp('case 2')
18 T2=1500 //F
19 v2=R*(T+460)/(P*144)/0.241
20 disp(v2)
21 T2=(T2+460)*(P1*v2/(P*(R*(T2+460)/(P*144))))
22 deltat=0.276*(T2-460-T)
23 dv2=v2-(R*(T+460)/(P*144))
24 printf ('change in volume = %.2 f cu ft/lb', dv2)
25 disp('At T1=2460 R, from table 1, case 3')
26 h1=634.34
27 pr1=407.3
28 pr2=pr1*P1/P
29 T2=1075 //F
30 h2=378.44

```

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

Chapter 12

Properties of Gaseous Mixtures

Scilab code Exa 12.1 Chapter 12 example 1

```
1  clc
2  //initialisation of variables
3  P= 15.0 //psia
4  T= 55 //F
5  P1= 0.2141 //psia
6  ma= 29 //lb
7  mb= 18 //lb
8  P2= 0.2141 //psia
9  P3= 0.3631 //psia
10 //CALCULATIONS
11 dp= P-P1
12 r= (dp*ma)/(P1*mb)
13 r1= r/(r+1)
14 r2= 1/(r+1)
15 r4= r2/r1
16 P= P2/P3
17 //RESULTS
18 printf ('relative humidity= %.2f ',P)
19 printf ('\n specific humidity= %.4f lb vapour/lb
    air ',r4)
```

Scilab code Exa 12.2 chapter 12 example 2

```
1  clc
2  //initialisation of variables
3  h= 29.5 //in
4  n= 75
5  T= 80 //F
6  h1= 10 //in
7  mw= 0.380*18
8  ma= 14.47*29
9  d= 13.6 //kg/m^3
10 P= 0.5069 //psi
11 //CALCULATIONS
12 Pw= (n/100)*P
13 P= (h+(h1/d))*(0.491)
14 pa= P-Pw
15 r= mw/ma
16 //RESULTS
17 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

```
1  clc
2  //initialisation of variables
3  n= 0.5
4  T= 75 //F
5  P= 14.7 //psia
6  pg= 0.4298 //psia
7  pw= 0.2149 //psia
8  //CALCULATIONS
9  pw1= n*pg
```

```

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

```

Scilab code Exa 12.4 chapter 12 example 4

```

1  clc
2  //initialisation of variables
3  r2= 0.0078 //lb water /lb dry air
4  r1= 0.0032 //lb water /lb dry air
5  h2= 25.33 //Btu/lb
6  h1= 12.9 //Btu/lb
7  pg= 0.1217 //psia
8  p= 14.7 //psia
9  h3= 13 //Btu/lb
10 n= 60
11 t2=70
12 t1=40
13 cpa=0.240
14 R2= 0.00788 //lb/lb of dry sir
15 w1= 0.00477 //lb/lb of dry sir
16 //CALCULATIONS
17 disp('Method 1')
18 w= r2-r1
19 q= h2-h1-w*h3
20 printf ('In method 1, Enthalpy =%.2f Btu/lb of dry
        air ',q)
21 disp('Method 2')
22 R1= 0.622*(n/100)*(pg/(p-pg))
23 R2=0.00788
24 w2=R2-R1
25 //All constants are obtained from steam tables
26 Q=cpa*(t2-t1)+R2*(1092.6)-R1*(1079.6) -w2*h3

```

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

Scilab code Exa 12.5 chapter 12 example 5

```
1 clc
2 //initialisation of variables
3 P= 1//atm
4 n= 70
5 T= 75 //F
6 T1= 70 //F
7 r1= 0.0131 //lb water/lb dry air
8 r2= 0.0093 //lb water/lb dry air
9 h1= 32.36 //Btu/lb dry air
10 h2= 27.03 //Btu/lb dry air
11 hd2= 23.40 //Btu/lb dry air
12 hf= 23.4 //Btu/lb dry liquid
13 hg= 1094.5 //Btu/lb dry liquid
14 //CALCULATIONS
15 R1= r1-r2
16 Qc= hd2-h1+R1*hf
17 Qh= h2-hd2
18 x= R1*(hg-hf)
19 y= x/(-Qc)
20 //RESULTS
21 printf ('Fraction of heat removed in the coil= %.2f
    ',y)
```

Chapter 13

Vapor cycles

Scilab code Exa 13.1 Chapter 13 example 1

```
1  clc
2  //initialisation of variables
3  P= 1 //psia
4  P1= 200 //psia
5  T= 750 //F
6  v3= 0.01614 //cu ft/lb
7  h1= 1399.2 //Bu/lb
8  h2= 976 //Btu/lb
9  h3= 69.7 //Btu/lb
10 //CALCULATIONS
11 dh= v3*(144/778)*(P1-P)
12 h4= h3+dh
13 Q1= h1-h4
14 Wt= h1-h2
15 Wp= h4-h3
16 n= (Wt-Wp)/Q1
17 w= 2545/Wt
18 //RESULTS
19 printf ('cycle efficiency = %.3f ',n)
20 printf ('\n steam rate= %.2f lb steam per hphr ',w)
```

Scilab code Exa 13.2 chapter 13 example 2

```
1 clc
2 //initialisation of variables
3 wt= 8 //lb/hphr
4 h1= 1399.2 //Btu/lb
5 h2s= 976 //Btu/lb
6 h2= 976 //Btu/lb
7 //CACLAULATIONS
8 Wt= 2545/wt
9 nt= Wt/(h1-h2s)
10 h21= h1-Wt
11 //RESULTS
12 printf ('Engine efficency = %.3f ',nt)
13 printf (' \n state of the exhaust steam= %.3f Btu/
    lb ',h21)
```

Scilab code Exa 13.3 chapter 13 example 3

```
1 clc
2 //initialisation of variables
3 h1=1474.5 //btu/lb
4 s1=1.5603 //btu/lb R
5 h2s=1277.5 //btu/lb
6 //Calculations and printfing
7 h2=h1-0.85*(h1-h2s)
8 printf ('h2= %.2f Btu/lb ',h2)
9 h3=1522.4 //btu/lb
10 s3=1.7623 //btu/lb R
11 h4s=948 //btu/lb
12 h4=h3- 0.85*(h3-h4s)
13 printf (' \n h4= %.2f Btu/lb ',h4)
```

```

14 h5=47.6 //btu/lb
15 h6=53.5 //btu/lb
16 disp('For the first rankine cycle')
17 h7s=840 //btu/lb
18 h7=h1-0.85*(h1-h7s)
19 printf ('h7= %.2f Btu/lb ',h7)
20 disp('For the second rankine cycle')
21 h8=1493.2 //btu/lb
22 s8=1.6903 //btu/lb R
23 h9s=866 //btu/lb
24 h9=h8-0.85*(h8-h9s)
25 printf ('h9= %.2f Btu/lb ',h9)
26 h11=51.5 //btu/lb
27 n1=0.401
28 n2=0.375
29 n3=0.366
30 e1=(n1-n2)/n2
31 printf ('\n Percentage Efficiency of reheat cycle
        compared to Rankine cycle for the first case = %
        .2f ',e1*100)
32 e2=(n1-n3)/n3
33 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

```

1 clc
2 //initialisation of variables
3 h1= 1371 //Btu/lb
4 h2s= 1149 //Btu/lb
5 h3= 118 //Btu/lb
6 Q1= 1253 //Btu/lb
7 W= 156 //Btu/lb
8 Qw= 680 //Btu/lb

```

```
9 //CALCULATIONS
10 Qh= h1-W-h3
11 y= W+0.9*Qh
12 r= y/Q1
13 x= Qh+Qw
14 z= y/x
15 //RESULTS
16 printf ('Fraction of energy supplied = %.2f ',r)
17 printf ('\n Fraction of energy supplied= %.2f ',z)
```

Chapter 14

Combustion Processes First law analysis

Scilab code Exa 14.1 Chapter 14 example 1

```
1 clc
2 //initialisation of variables
3 M= 114 //lb
4 Mo= 32 //lb
5 Mn= 28 //lb
6 Mc= 44 //lb
7 Mw= 18 //lb
8 //CALCULATIONS
9 Ma= (12.5*Mo+(12.5)*(79/21)*Mn)/114
10 //RESULTS
11 printf ('Theoretical air for combustion= %.1f lb air
    per lb C8H18 ',Ma)
```

Scilab code Exa 14.4 chapter 14 example 4

```
1 clc
```



```

2 //initialisation of variables
3 mO2=1.33 //lb
4 mCO2=3.67 //lb
5 CvO2=0.155 //Btu/lb F
6 CvCO2=0.165 //Btu/lb F
7 Cc=0.170 //Btu/lb F
8 t2=1000 //F
9 tB=68 //F
10 t=300 //F
11 mC=1
12 mO=4
13 //Calculations
14 deltaE1=mO2*CvO2*(t2-tB) + mCO2*CvCO2*(t2-tB)
15 deltaE2=mC*CC*(tB-t) + mO*CvO2*(tB-t)
16 E= -14087 //Btu
17 Q=deltaE1+E+deltaE2
18 //Results
19 printf ('Heat Transfer from the system = %.2f',Q)

```

Scilab code Exa 14.5 chapter 14 example 5

```

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

```

Scilab code Exa 14.6 chapter 14 example 6

```
1 clc
2 //initialisation of variables
3 mC=1 //lb
4 mO2=2.67 //lb
5 mN2=8.78 //lb
6 mCO2=3.67 //lb
7 mN2=8.78 //lb
8 tB=77 //F
9 deltaH=14087 //Btu/lb
10 CpCO2=0.196 //Btu/lb F
11 CpCO2f=0.3 //Btu/lb F
12 CpN2=0.248 //Btu/lb F
13 CpN2f=0.285 //Btu/lb F
14 //Calculations
15 t2= tB+ deltaH/(mCO2*CpCO2 + mN2*CpN2)
16 t2f=tB+ deltaH/(mCO2*CpCO2f + mN2*CpN2f)
17 //Results
18 printf ('In case 1, t2 = %.1f F',t2)
19 printf ('\n In case 2, t2f = %.1f F',t2f)
```

Scilab code Exa 14.7 chapter 14 example 7

```
1 clc
2 //initialisation of variables
3 HR=14087 //Btu
4 HRC=3952 //Btu
5 x1=0.9
6 x2=0.05
7 //Calculations
8 HR1=x1*HR
9 HR2=x2*HRC
10 e=(HR2+HR1)/HR
11 //Results
```

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

Scilab code Exa 14.8 chapter 14 example 8

```
1 clc  
2 //initialisation of variables  
3 h= 19500 //Btu  
4 w= 700 //lb/hr  
5 Q= 10240000  
6 //CALCULATIONS  
7 Q1= w*h  
8 e= Q/Q1  
9 //RESULTS  
10 printf ( 'Efficiency= %.2f ', e)
```

Chapter 15

Gas cycles

Scilab code Exa 15.1 Chapter 15 example 1

```
1  clc
2  //initialisation of variables
3  p= 15 //psia
4  p1= 75 //psia
5  T= 550 //R
6  T1= 1700 //R
7  k= 1.4
8  //CALCULATIONS
9  Ta= T*(p1/p)^((k-1)/k)
10 Tc= T1/((p1/p)^((k-1)/k))
11 cp= 0.24
12 Q1= cp*(T1-Ta)
13 Q2= cp*(Tc-T)
14 Wnet= Q1-Q2
15 n= Wnet/Q1
16 hb= 422.59 //Btu/lb
17 hc= 269.27 //Btu/lb
18 ha= 208.41 //Btu/lb
19 hd= 131.46 //btu/lb
20 Q1i= hb-ha
21 Q2i= hc-hd
```

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

Scilab code Exa 15.2 chapter 15 example 2

```
1 clc
2 //initialisation of variables
3 p= 15 //psia
4 p1= 75 //psia
5 T= 550 //R
6 T1= 1700 //R
7 k= 1.4
8 n= 75
9 cp= 0.24
10 //CALCULATIONS
11 Ta= T*(p1/p)^((k-1)/k)
12 Tc= T1/((p1/p)^((k-1)/k))
13 Ta1= (n/100)*(Tc-Ta)+Ta
14 Tc1= Ta+Tc-Ta1
15 Q1= cp*(T1-Ta1)
16 Q2= cp*(Tc1-T)
17 Wnet= Q1-Q2
18 n1= Wnet/Q1
19 //CALCULATIONS
20 printf ( 'Efficiency = %.2f ',n1)
```

Scilab code Exa 15.3 chapter 15 example 3

```
1 clc
2 //initialisation of variables
```

```
3 h1= 124.27 //Btu/lb
4 Pr1= 1.2147 //psia
5 r= 6
6 p4= 15 //psia
7 p1= 15 //psia
8 h2s= 197.5 //Btu/lb
9 Wnet= 48.9 //Btu/lb air
10 hs= 18500 //Btu/lb
11 wfbywa= 0.0146 //lb fuel/lb sir
12 W= 2545 //Btu/lb air
13 dh=-91.5 //Btu/lb
14 Wc= 91.5 //Btu/lb air
15 //CALCULATIONS
16 n= Wnet/(wfbywa*hs)
17 n1= W/Wnet
18 n2= Wc/Wnet
19 //RESULTS
20 printf ( 'Efficiency = %.3f ',n)
21 printf ( ' \n air rate= %.1f lb air/hphr ',n1)
22 printf ( ' \n back work ratio= %.2f ',n2)
```

Chapter 16

Fluid Flow Nozzles and Turbines

Scilab code Exa 16.1 chapter 16 example 1

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

Scilab code Exa 16.2 chapter 16 example 2

```
1  clc
2  //initialisation of variables
3  w=10000 //lb/hr
4  p0=250 //psia
5  T1=500 //F
6  Pf=1 //psia
7  vc=0.949
8  dc=1
9  h0=1263.4 //btu/lb
10 s0=1.5949 //btu/lb R
11 v2=276 //cu ft/lb
12 //Calculations
13 pt=0.55*p0
14 disp('from tables')
15 hts=1208.2 //btu/lb
16 vts=3.415 //cu ft/lb
17 h2s=891. //btu/lb
18 Vts=sqrt(2*32.174*778*(h0-hts))
19 w=w/3600 //lb/sec
20 cw=1
21 at=w*vts/(cw*Vts)
22 printf ('Throat area = %.5f ft^2',at)
23 V2=sqrt(2*32.174*778*(h0-h2s))
24 eta=0.9
25 h2=h0-eta*(h0-h2s)
26 a2s=w*v2/(cw*V2)
27 printf ('\n Exit area = %.5f ft^2',a2s)
```

Scilab code Exa 16.3 chapter 16 example 3


```

1  clc
2  //initialisation of variables
3  k=1.4
4  ptbyp0=0.53
5  T0=800 //R
6  cp=778
7  R=0.0425864
8  P0=150 //psia
9  Pt=15 //psia
10 w=1 //lb/sec
11 cw=1.0043782
12 //Calculations
13 Pt2=ptbyp0*Pt
14 Tts=T0*(ptbyp0)^((k-1)/k)
15 Vts=sqrt(2*32.174*cp*0.24*(T0-Tts))
16 printf ('Exit velocity case 1= %.2f fps ',Vts)
17 vts=3.12 //cu ft/lb
18 at=w*vts/(cw*Vts)
19 printf ('\n Throat Area = %.5f ft^2', at)
20 T2s=T0*(Pt/P0)^((k-1)/k)
21 eta=0.88
22 T2=T0-eta*(T0-T2s)
23 V2=sqrt(2*32.174*cp*0.24*(T0-T2))
24 printf ('\n Exit velocity = %.2f fps ', V2)
25 v2=11.4 //cu ft/lb
26 a2=w*v2/V2
27 printf ('\n Exit area = %.5f ft^2',a2)

```

Chapter 17

Gas compression

Scilab code Exa 17.1 chapter 17 example 1

```
1  clc
2  //initialisation of variables
3  R= 53.31
4  T= 80 //F
5  P2= 90//psia
6  P1= 15 //psia
7  n= 1.4
8  n1= 1.3
9  cv= 0.171
10 //CALCULATIONS
11 Wk= (n/(n-1))*R*(T+460)*((P2/P1)^((n-1)/n)-1)
12 Wn= (n1/(n1-1))*R*(T+460)*((P2/P1)^((n1-1)/n1)-1)
13 Wt= R*(T+460)*log(P2/P1)
14 Q= cv*0.778*((n-n1)/(1-n1))*(T+460)*((P2/P1)^((n-1)/
    n)-1)
15 //RESULTS
16 printf ('Heat transfered from the air in each case= %
    .1f Btu/lb ',Q)
```

Scilab code Exa 17.2 chapter 17 example 2

```
1 clc
2 //initialisation of variables
3 R= 53.31
4 T= 80 //F
5 P2= 90//psia
6 P1= 15 //psia
7 n= 1.4
8 n1= 1.3
9 cv= 0.171
10 //CALCULATIONS
11 Wk= (n/(n-1))*R*(T+460)*((P2/P1)^((n-1)/n)-1)
12 Wn= (n1/(n1-1))*R*(T+460)*((P2/P1)^((n1-1)/n1)-1)
13 Wt= R*(T+460)*log(P2/P1)
14 nc= Wt/Wn
15 nc1=Wk/Wn
16 ////RESULTS
17 printf ('Thermal effeciency= %.2f ',nc)
18 printf ('\n Isothermal effeciency= %.2f ',nc1)
```

Scilab code Exa 17.3 chapter 17 example 3

```
1 clc
2 //initialisation of variables
3 R= 53.31
4 T= 80 //F
5 P2= 90//psia
6 P1= 15 //psia
7 n= 1.4
8 cp= 0.240
9 nc= 0.95
10 n1= 1.3
11 //CALCULATIONS
12 Wk= (n/(n-1))*(R)*(T+460)*((P2/P1)^((n-1)/n)-1)
```

```

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

```

Scilab code Exa 17.4 chapter 17 example 4

```

1  clc
2  //initialisation of variables
3  P1= 83.5//psia
4  P2= 5 //psia
5  n= 3 //percent
6  n1= 1.25
7  //CALCULATIONS
8  nv= 1-(n/100)*((P1/P2)^(1/n1)-1)
9  nv1= 1-(n/100)*(sqrt((P1/P2)^(1/n1))-1)
10 //RESULTS
11 printf ('single-stage compression = %.3f ',nv)
12 printf ('\n two-stage compression = %.3f ',nv1)

```

Chapter 18

Refrigeration

Scilab code Exa 18.1 chapter 18 example 1

```
1  clc
2  //initialisation of variables
3  T2 = 0 //F
4  T1= 76 //F
5  h1= 611.8 //Btu/lb
6  h4= 127.4 //Btu/lb
7  h2= 704.4 //Btu/lb
8  x= 10000 //Btu/hr
9  v1= 9.116 //cu ft/lb
10 n=70
11 //CALCULATIONS
12 CP= (T2+460)/(T1-T2)
13 CP1= (h1-h4)/(h2-h1)
14 w= (x/60)/(h1-h4)
15 PD=(w*v1)/(n/100)
16 //RESULTS
17 printf ('CP1 = %.2 f ',CP)
18 printf (' \n CP2 = %.2 f ',CP1)
19 printf (' \n PD = %.2 f cu ft/min ',PD)
```

Chapter 19

Heat Transmission

Scilab code Exa 19.2 chapter 19 example 2

```
1  clc
2  //initialisation of variables
3  t= 8 //in
4  t1= 1 //in
5  k= 0.50 //Btu/hr ft F
6  k1= 0.02 //Btu/hr ft F
7  A= 1 //ft^2
8  T= 60 //F
9  T1= -20 //F
10 //CALCULATIONS
11 Rc= (t/12)/(k*A)
12 Rf= (t1/12)/(k1*A)
13 R= Rc+Rf
14 q= (T-T1)/R
15 T2= (T+(Rc/Rf)*T1)/(1+(Rc/Rf))
16 //RESULTS
17 printf ('Rate of heat flow= %.1f Btu/hr ',q)
18 printf ('\n Temperature at the interface= %.1f F',
    T2)
```

Scilab code Exa 19.3 chapter 19 example 3

```
1  clc
2  //initialisation of variables
3  h1= 2500 //Btu/sq ft hr F
4  r= 10 //in
5  t= 0.375 //in
6  Ts= 500 //F
7  Ta= 80 //F
8  r2= 5.375 //in
9  r1= 5 //in
10 r3= 7.375 //in
11 kp= 26 //Btu ft/hr
12 ki= 0.045 //Btu ft/hr
13 h1= 2500 //Btu/sq ft hr F
14 h3= 1.6 //Btu/sq ft hr F
15 r4= 14.750
16 //CALCULATIONS
17 R1= 1/(h1*%pi*(r/12))
18 Rp= log(r2/r1)/(2*%pi*kp)
19 Ri= log(r3/r2)/(2*%pi*ki)
20 R3= 1/(h3*%pi*(r4/12))
21 R0= R1+Rp+Ri+R3
22 T3=Ta+ (Ts-Ta)*R3/R0
23 //RESULTS
24 printf ('Temperature at the interface= %.6f F',T3)
```

Scilab code Exa 19.4 chapter 19 example 4

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

```

4  cph= 0.5 //Btu/lb F
5  th1= 170 //F
6  th2= 120 //F
7  cpc= 1 //Btu/lb F
8  tc2= 140 //F
9  tc1= 100 //F
10 t= 140 //F
11 U= 120 //Btu/sq ft hr F
12 //CALCULATIONS
13 dh= t-th2
14 dc= tc2-tc1
15 wc= (wh*cph*(th1-th2))/(cpc*dc)
16 dtm= (-(tc1-th2)-(th1-tc2))/log((tc1-th2)/(-th1+tc2)
      )
17 q= wh*cph*(th1-th2)
18 A= q/(U*dtm)
19 th2= ((wh/wc)*(cph/cpc)*th1+tc1)/((wh/wc)*(cph/cpc)
      +1)
20 wc1= (wh*cph*(th1-th2))/(cpc*(th2-tc1))
21 //RESULTS
22 printf ('Water flow rate= %.f lb/hr ',wc)
23 printf ('\n Area of heat transfer surface= %.f sq
      ft ',A)
24 printf ('\n temperature of the oil= %.f F ',th2)
25 printf ('\n flow rate= %.f lb/hr ',wc1*2)

```

Scilab code Exa 19.5 chapter 19 example 5

```

1  clc
2  //initialisation of variables
3  Tw= 200 //F
4  Ta= 600 //F
5  V= 100 //fps
6  Di= 0.902 //in
7  d= 0.0375 //lb/cu ft

```



```

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

```

Scilab code Exa 19.6 chapter 19 example 6

```

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

```

Scilab code Exa 19.7 chapter 19 example 7

```

1 clc
2 //initialisation of variables

```

```

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

```

Scilab code Exa 19.8 chapter 19 example 8

```

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

```
