

Scilab Textbook Companion for
Thermodynamics: From Concepts To
Applications
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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

Basic concepts

Scilab code Exa 2.2 chapter 2 example 2

```
1  clc
2  //initialisation of variables
3  n= 0.25 // k mol
4  M= 32 //kg/kmol
5  V= 0.5 //m^3
6  //CALCULATIONS
7  m= n*M
8  d= m/V
9  v= 1/d
10 v1= V/n
11 //RESULTS
12 printf ('mass of oxygen = %.f kg',m)
13 printf ('\n density of oxygen = %.f kg/m^3',d)
14 printf ('\n specific volume = %.4f kg/m^3',v)
15 printf ('\n molar specific volume = %.f m^3/kmol',v1
    )
```

Chapter 3

Work energy and heat first law of thermodynamics

Scilab code Exa 3.3 chapter 3 example 3

```
1 clc
2 //initialisation of variables
3 m= 5 //kg
4 g= 9.8 //m/sec^2
5 k= 500 //N/m
6 //CALCULATIONS
7 x= m*g/k
8 W= -m*g*x
9 //RESULTS
10 printf ('work interaction of spring = %.2f J',W)
```

Scilab code Exa 3.4 chapter 3 example 4

```
1 clc
2 //initialisation of variables
3 m= 500 //kg
```

```

4 V= 50 //L
5 P= 700 //kPa
6 T= 25 //C
7 P0= 100 //kPa
8 g= 9.8 //m/sec^2
9 A= 200 //cm^2
10 V1= 100 //L
11 //CALCULATIONS
12 pe= P0*10^3+(m*g/(A*10^-4))
13 W= pe*(V1-V)*10^-6
14 //RESULTS
15 printf ('work of the gas = %.2f kJ',W)

```

Scilab code Exa 3.5 chapter 3 example 5

```

1 clc
2 //initialisation of variables
3 W= 5 //kJ
4 Q= 23 //kJ
5 Q1= -50 //kJ
6 W1= 0 //kJ
7 //CALCULATIONS
8 E1= Q-W
9 E2= Q1-W1
10 E3= -(E1+E2)
11 W3= -E3
12 //RESULTS
13 printf ('energy change in process 1 = %.f kJ',E1)
14 printf ('\n energy change in process 2 = %.f kJ',E2)
15 printf ('\n energy change in process 3 = %.f kJ',E3)
16 printf ('\n Work in third process = %.f kJ',W3)

```

Scilab code Exa 3.6 chapter 3 example 6

```
1 clc
2 //initialisation of variables
3 V= 12 //km/L
4 //CALCULATIONS
5 MPG= V*3.7854/1.609
6 //RESULTS
7 printf ('car mileage = %.2f MPG',MPG)
```

Scilab code Exa 3.7 chapter 3 example 7

```
1 clc
2 //initialisation of variables
3 p= 800 //atm
4 P= 10000 //psi
5 x= 14.696 //psi/atm
6 //CALCULATIONS
7 P1= p*x
8 //RESULTS
9 if (P1>P) then
10 disp("Salesman is honest")
```

Chapter 4

simple systems

Scilab code Exa 4.1 chapter 4 example 1

```
1  clc
2  //initialisation of variables
3  V= 0.5 //m^3
4  M= 18.02 //kg/kmol
5  T= 350 //C
6  R= 0.4617 //kJ/kg K
7  a= 1.702 //m^6 kPa/kg^2
8  b= 0.00169 //m^3/kg
9  n= 1.5 //kmol
10 //CALCULATIONS
11 m= n*M
12 v= V/m
13 p= R*(T+273.15)/v
14 P= (R*(T+273.15)/(v-b))-(a/v^2)
15 P1= R*(273.15+T)*%e^(-a/(R*v*(273.15+T)))/(v-b)
16 //RESULTS
17 printf ('mass of water vapour = %.2f kg',m)
18 printf ('\n specific volume of water vapour = %.4f m
    ^3/kg',v)
19 printf ('\n pressure of water vapour = %.f kPa',p)
20 printf ('\n pressure of water vapour = %.f kPa',P)
```

```
-12)
21 printf ('\n pressure of water vapour = %.f kPa',P1)
```

Scilab code Exa 4.2 chapter 4 example 2

```
1 clc
2 //initialisation of variables
3 m= 0.3 //kg
4 T= 25 //C
5 T1= 150 //C
6 cv= 0.7423 //kJ/kg K
7 //CALCULATIONS
8 Q= m*cv*(T1-T)
9 //RESULTS
10 printf ('heat interaction = %.2f kJ',Q)
```

Scilab code Exa 4.3 chapter 4 example 3

```
1 clc
2 //initialisation of variables
3 m= 5000 //kg
4 cp= 1.4 //kJ/kg K
5 T2= 27.6 //K
6 T1= 22 //K
7 t= 40 //min
8 P= 20 //kW
9 //CALCULATIONS
10 H= m*cp*(T2-T1)
11 W= -P*t*60
12 Q= H+W
13 dT= -W/(m*cp)
14 //RESULTS
15 printf ('heat interaction = %.f kJ',Q)
```

```
16 printf ('\n temperature rise = %.2f C',dT)
```

Scilab code Exa 4.4 chapter 4 example 4

```
1 clc
2 //initialisation of variables
3 T= 300 //C
4 p= 2 //Mpa
5 T1= 300 //C
6 p1= 20 //Mpa
7 T2= 300 //C
8 p2= 8.501 //Mpa
9 //CALCULATIONS
10 v= 0.12547
11 v1= 0.00136
12 u= 2772.6
13 u1= 1306.1
14 h= 3023.5
15 h1= 1333.3
16 //RESULTS
17 printf ('volume = %.5f m^3/kg',v)
18 printf ('\n volume = %.5f m^3/kg',v1)
19 printf ('\n internal energy = %.1f kJ/kg',u)
20 printf ('\n internal energy = %.1f kJ/kg',u1)
21 printf ('\n enthalpy = %.1f kJ/kg',h)
22 printf ('\n enthalpy = %.1f kJ/kg',h1)
```

Scilab code Exa 4.5 chapter 4 example 5

```
1 clc
2 //initialisation of variables
3 vf= 0.001404 //m^3/kg
4 x= 0.8
```



```

5  vg= 0.02167 //m^3/kg
6  uf= 1332 //kJ/kg
7  ug= 1231 //kJ/kg
8  hf= 1344 //kJ/kg
9  hg= 1404.9 //kJ/kg
10 //CALCULATIONS
11 v= vf+x*(vg-vf)
12 u= uf+x*ug
13 h= hf+x*hg
14 //RESULTS
15 printf ('volume = %.5f m^3/kg',v)
16 printf ('\n internal energy = %.1f kJ/kg',u)
17 printf ('\n enthalpy = %.1f kJ/kg',h)

```

Scilab code Exa 4.6 chapter 4 example 6

```

1  clc
2  //initialisation of variables
3  T= 296 //K
4  T1= 250 //K
5  T2= 300 //K
6  v= 0.1257 //m^3/kg
7  v1= 0.11144 //m^3/kg
8  u1= 27772.6 //kJ/kg
9  u2= 2679.6 //kJ/kg
10 h1= 3023.5 //kJ/kg
11 h2= 2902.5 //kJ/kg
12 s1= 6.7664 //kJ/kg K
13 s2= 6.5433 //kJ/kg K
14 //CALCULATIONS
15 a1= (T-T1)/(T2-T1)
16 a2= 1-a1
17 V= a1*v+a2*v1
18 U= a1*u1+a2*u2
19 H= a1*h1+a2*h2

```

```

20 S= a1*s1+a2*s2
21 //RESULTS
22 printf ( 'a2 = %.3 f ',a2)
23 printf ( '\n specific volume = %.5 f m^3/kg ',V)
24 printf ( '\n internal energy = %.1 f kJ/kg ',u)
25 printf ( '\n enthalpy = %.1 f kJ/kg ',H)
26 printf ( '\n Entropy = %.1 f kJ/kg ',S)

```

Scilab code Exa 4.7 chapter 4 example 7

```

1 clc
2 //initialisation of variables
3 v= 0.15 //m^3/kg
4 v1= 0.13857 //m^3/kg
5 v2= 0.1512 //m^3/kg
6 v3= 0.050 //m^3/kg
7 vf= 0.001177 //m^3/kg
8 vg= 0.09963 //m^3/kg
9 uf= 906.44 //kJ/kg
10 ufg= 1693.8 //kJ/kg
11 //CALCULATIONS
12 a1= (v-v1)/(v2-v1)
13 a2= 1-a1
14 x= (v3-vf)/(vg-vf)
15 u= uf+x*ufg
16 //RESULTS
17 printf ( 'a2 = %.3 f ',a2)
18 printf ( '\n internal energy = %.1 f kJ/kg ',u)

```

Scilab code Exa 4.8 chapter 4 example 8

```

1 clc
2 //initialisation of variables

```

```

3 T= 250 //C
4 T2= 300 //C
5 v300= 0.6548 //m^3/kg
6 v250= 0.591 //m^3/kg
7 v= 0.6 //m^3/kg
8 u= 3000 //kJ/kg
9 u250= 2726.1 //kJ/kg
10 u300= 2804.8 //kJ/kg
11 T2= 510.30
12 u2= 3145.26 //kJ/kg
13 p= 0.4 //Mpa
14 p2= 0.2 //Mpa
15 //CALCULATIONS
16 T1= T1+((v-v250)/(v300-v250))*(T2-T)
17 u1= u250+((v-v250)/(v300-v250))*(u300-u250)
18 du= u1-u
19 p1= p+((u-u1)/(u2-u1))*p2
20 //RESULTS
21 printf ('pressure = %.3f Mpa',p1)
22 printf ('\n temperature = %.f C',T2)

```

Scilab code Exa 4.9 chapter 4 example 9

```

1 clc
2 //initialisation of variables
3 n= 1.5 //kmol
4 V= 0.5 //m^3
5 M= 18.02 //kg
6 //CALCULATIONS
7 m= n*M
8 v= V/m
9 //RESULTS
10 printf ('mass = %.2f kg',m)
11 printf ('\n sepcific volume = %.4f m^3/kg',v)

```

Scilab code Exa 4.12 chapter 4 example 12

```
1  clc
2  //initialisation of variables
3  V= 0.2 //m^3
4  v1= 0.02995 //m^3/kg
5  u2= 2826.7 //kJ/kg
6  u1= 2747.7 //kJ/kg
7  h2= 3092.5 //kJ/kg
8  h1= 2987.3 //kJ/kg
9  p= 4 //Mpa
10 v2= 0.06645 //m^3/kg
11 v1= 0.02995 //m^3/kg
12 //CALCULATIONS
13 m= V/v1
14 U= m*(u2-u1)
15 H= m*(h2-h1)
16 W= m*p*10^3*(v2-v1)
17 Q= U+W
18 //RESULTS
19 printf (' work = %.1f kJ ',W)
20 printf ('\n heat interaction = %.1f kJ ',Q)
```

Scilab code Exa 4.13 chapter 4 example 13

```
1  clc
2  //initialisation of variables
3  m= 6.678 //kg
4  u2= 2826.7 //kJ/kg
5  u1= 2747.7 //kJ/kg
6  p1= 8 //Mpa
7  p2= 7 //Mpa
```

```

8 p3= 6 //Mpa
9 p4= 5 //Mpa
10 p5= 4 //Mpa
11 v1= 29.95 //L/kg
12 v2= 35.24 //L/kg
13 v3= 42.23 //L/kg
14 v4= 51.94 //L/kg
15 v5= 66.45 //L/kg
16 //CALCULATIONS
17 U= m*(u2-u1)
18 W= m*0.5*((p1+p2)*(v2-v1)+(p2+p3)*(v3-v2)+(p3+p4)*
      v4-v3)+(p4+p5)*(v5-v4))
19 Q=U+W
20 //RESULTS
21 printf (' work = %.1f kJ ',W)
22 printf ('\n heat interaction = %.f kJ ',Q)

```

Scilab code Exa 4.14 chapter 4 example 14

```

1 clc
2 //initialisation of variables
3 p0= 100 //kpa
4 A= 0.1 //m^2
5 F= 20 //kN
6 m3= 0.8873 //kg
7 m1= 1.1384 //kg
8 m2= 0.2511 //kg
9 u1= 3116.2 //kJ/kg
10 u2= 2728.7 //kJ/kg
11 v3= 0.9942 //m^3/kg
12 //CALCULATIONS
13 pe= (p0+(F/A))/1000
14 h3= (m1*u1-m2*u2)/m3
15 z3= m3*v3/A
16 //RESULTS

```

```
17 printf ( ' final pressure = %.1f Mpa ',pe)
18 printf ( ' \n enthalpy = %.1f kJ/kg ',h3)
19 printf ( ' \n piston rise = %.2f m ',z3)
```

Chapter 5

Ideal Gas

Scilab code Exa 5.1 chapter 5 example 1

```
1  clc
2  //initialisation of variables
3  R= 8.314 //J/mol K
4  M= 18.016 //gms
5  T= 400 //C
6  p= 0.01 //Mpa
7  p1= 0.1 //Mpa
8  p2= 20 //Mpa
9  //CALCULATIONS
10 v= R*(273.156+T)/(M*p*1000)
11 v1= R*(273.156+T)/(M*p1*1000)
12 v2= R*(273.156+T)/(M*p2*1000)
13 //RESULTS
14 printf (' specific voulme = %.3f m^3/kg ',v)
15 printf (' \n specific voulme = %.3f m^3/kg ',v1)
16 printf (' \n specific voulme = %.3f m^3/kg ',v2)
```

Scilab code Exa 5.3 chapter 5 example 3

```

1  clc
2  //initialisation of variables
3  V= 20 //L
4  m= 0.050 //gms
5  M= 29 //gms
6  T1= 20 //C
7  T2= 150 //C
8  k= 1.4
9  V1= 0.05 //m^3
10 //CALCULATIONS
11 p1= m*R*(273.15+T1)/(M*(V/10))
12 p2= m*R*(273.15+T2)/(M*(V/10))
13 dU= p1*V1*(((273.15+T2)/(273.15+T1))-1)*100/(k-1)
14 dH= k*dU
15 //RESULTS
16 printf (' initial pressure = %.1f kPa',p1)
17 printf (' \n final pressure = %.1f kPa',p2)
18 printf (' \n internal energy = %.2f kJ',dU)
19 printf (' \n enthalpy = %.2f kJ',dH)

```

Scilab code Exa 5.4 chapter 5 example 4

```

1  clc
2  //initialisation of variables
3  T1= 200 //K
4  p= 600 //kPa
5  p1= 50 //kPa
6  n= 1.8
7  M= 4 //gms
8  k= 5/3
9  m= 0.007 //gms
10 R= 8.314 //J/mol K
11 //CALCULATIONS
12 T2= T1*(p/p1)^((n-1)/n)
13 W= m*R*(T1-T2)/((n-1)*M)

```



```

14 Q= ((n-k)*m*R*(T2-T1))/((n-1)*(k-1)*M)
15 //RESULTS
16 printf ( ' final temperature = %.2 f K',T2)
17 printf ( ' \n work = %.3 f kJ ',W)
18 printf ( ' \n energy = %.3 f kJ ',Q)

```

Scilab code Exa 5.5 chapter 5 example 5

```

1 clc
2 //initialisation of variables
3 p1= 300 //kPa
4 V1= 0.03 //m^3
5 V2= 0.08 //m^3
6 T1= 27 //C
7 //CALCULATIONS1
8 T2= T1+273
9 p2= p1*(V1/V2)*(T2/(T1+273))
10 W= 0
11 Q= 0
12 //RESULTS
13 printf ( ' final temperature = %.2 f K',T2)
14 printf ( ' \n final pressure = %.1 f kPa ',p2)
15 printf ( ' \n work = %.f kJ ',W)
16 printf ( ' \n energy = %.f kJ ',Q)

```

Scilab code Exa 5.6 chapter 5 example 6

```

1 clc
2 //initialisation of variables
3 p1= 2 //Mpa
4 V1= 0.2 //m^3
5 R= 8.314 //J/mol K
6 T1= 500 //C

```

```

7 M= 28 //gms
8 p2= 0.3 //Mpa
9 T2= 250 //C
10 k= 1.4
11 A= 0.1 //m^2
12 //CALCULATIONS
13 m1= p1*10^3*V1*M/(R*(273.15+T1))
14 m2= p2*10^3*V1*M/(R*(273.15+T2))
15 m3= -(m2-m1)
16 T3= (m1*(273.15+T1)-m2*(273.15+T2))/(k*m3)
17 z3= m3*R*T3/(p2*10^3*A*M)
18 //RESULTS
19 printf (' mass of nitrogen = %.4f kg',m3)
20 printf (' \n final temperature = %.1f K',T3)
21 printf (' \n piston rise = %.2f m',z3)

```

Scilab code Exa 5.7 chapter 5 example 7

```

1 clc
2 //initialisation of variables
3 m= 0.3 //kg
4 R= 8.314 //J/mol K
5 M= 28 //gms
6 T1= 500 //C
7 p1= 500 //kPa
8 k= 1.4
9 V3= 0.3 //m^2
10 //CALCULATIONS
11 V1= m*R*(273.15+T1)/(M*p1)
12 T3= k*(273.15+T1)
13 p3= m*R*T3*100/(M*V)
14 //RESULTS
15 printf (' final pressure = %.1f kPa',p3)

```

Chapter 6

Control Volume

Scilab code Exa 6.1 chapter 6 example 1

```
1  clc
2  //initialisation of variables
3  R= 8.314 //J/mol K
4  M= 29 //gms
5  T= 80 //C
6  p= 104 ///kPa
7  v= 30 //m/sec
8  m= 8000 //kg/h
9  //CALCULATIONS
10 V= R*(273.15+T)/(M*p)
11 A= m*V/(3600*v)
12 D= sqrt(4*A/%pi)
13 //RESULTS
14 printf (' diameter = %.5 f m^2 ',D)
```

Scilab code Exa 6.2 chapter 6 example 2

```
1  clc
```

```

2 //initialisation of variables
3 R= 8.314 //J/mol K
4 M= 29 //gms
5 T1= 230 //C
6 p1= 30 ///bar
7 k= 1.4
8 T2= 180 //C
9 v1= 10 //m/s
10 p2= 20 //bar
11 m2= 0.84 //kg/s
12 //CALCULATIONS
13 V1= R*(273.15+T1)/(M*p1*100)
14 cp= k*R/((k-1)*M)
15 A= m2*V1*10^4/v1
16 v2= sqrt(v1^2+2*cp*10^3*(T1-T2))
17 V2= R*(273.15+T2)/(M*p2*100)
18 A2= m2*V2*10^4/v2
19 //RESULTS
20 printf (' inlet area = %.1f cm^2 ',A)
21 printf (' \n inlet area = %.2f cm^2 ',A2)

```

Scilab code Exa 6.3 chapter 6 example 3

```

1 clc
2 //initialisation of variables
3 h= 2676.2 //kJ/kg
4 hf= 721.11 //kJ/kg
5 hg= 2679.1 //kJ/kg
6 vf= 0.001115 //m^3/kg
7 vg= 0.2404 //m^3/kg
8 //CALCULATIONS
9 x= (h-hf)/(hg-hf)
10 v1= vf+x*(vg-vf)
11 //RESULTS
12 printf (' quantity = %.4f ',x)

```

```
13 printf ( ' \n specific volume = %.4f m^3/kg ',v1)
```

Scilab code Exa 6.4 chapter 6 example 4

```
1 clc
2 //initialisation of variables
3 h4= 419.05 //kJ/kg
4 h1= 434.92 //kJ/kg
5 m= 2.5 //kg/s
6 h2= 3272.4 //kJ/kg
7 h3= 2601.7 //kJ/kg
8 v1= 0.001401 //m^3/kg
9 V1= 5 //m/s
10 v2= 0.03817 //m^3/kg
11 V2= 20 //m/s
12 v3= 0.8415 //m^3/kg
13 V3= 100 //m/s
14 v4= 0.00104 //m^3/kg
15 V4= 5 //m/s
16 //CALCULATIONS
17 W41= m*(h4-h1)
18 Q12= m*(h2-h1)
19 W23= m*(h2-h3)
20 Q34= m*(h4-h3)
21 A1= m*v1*10^4/V1
22 A2= m*v2*10^4/V2
23 A3= m*v3*10^4/V3
24 A4= m*v4*10^4/V4
25 //RESULTS
26 printf ( ' rate of pump = %.1f kW',W41)
27 printf ( ' \n rate of heat ineraction = %.f kW',Q12)
28 printf ( ' \n rate of work of the turbine = %.1f W',
           W23)
29 printf ( ' \n rate of heat ineraction = %.f kW',Q34)
30 printf ( ' \n area = %.2f cm^2 ',A1)
```

```
31 printf ( ' \n area = %.2 f cm^2 ', A2)
32 printf ( ' \n area = %.2 f cm^2 ', A3)
33 printf ( ' \n area = %.2 f cm^2 ', A4)
```

Scilab code Exa 6.5 chapter 6 example 5

```
1 clc
2 //initialisation of variables
3 m1= 0.03 //kg
4 R= 8.314 //J/mol K
5 T1= 300 //C
6 p1= 120 //kPa
7 k= 5/3
8 M=4 //kg
9 p2= 600 //kPa
10 //CALCULATIONS
11 V= m1*R*(273.15+T1)/(p1*M)
12 m2= m1*((p2/p1)+k-1)/k
13 T2= p2*V*M/(m2*R)
14 //RESULTS
15 printf ( ' mass of helium = %.3 f kg ', m2)
16 printf ( ' \n temperature of helium = %.1 f K ', T2)
```

Scilab code Exa 6.6 chapter 6 example 6

```
1 clc
2 //initialisation of variables
3 m1= 0.03 //kg
4 v1= 2.1977 //m^3/kg
5 h2= 3073.8 //kJ/kg
6 h1= 3061.6 //kJ/kg
7 p2= 600 //kPa
8 p1= 120 //kPa
```

```
9 //CALCULATIONS
10 V=m1*v1
11 r= ((h2-h1)/v1)+p2-p1
12 //RESULTS
13 printf ( ' volume of container = %.5f m^3 ',V)
14 printf ( ' \n pressure = %.2f kPa ',r)
```

Chapter 7

Heat Engines and Second Law of Thermodynamics

Scilab code Exa 7.1 chapter 7 example 1

```
1  clc
2  //initialisation of variables
3  m= 0.35 //kg
4  u2= 211.785 //kJ/kg
5  u1= 182.267 //kJ/kg
6  p2= 300 //kPa
7  v3= 0.085566 //kJ/kg
8  v2= 0.076218 //kJ/kg
9  h3= 260.391 //kJ/kg
10 h2= 234.650 //kJ/kg
11 u4= 199.460 //kJ/kg
12 u3= 234.721 //kJ/kg
13 p4= 250 //kPa
14 v1= 0.076218 //kJ/kg
15 v4= 0.085566 //kJ/kg
16 h1= 201.322 //kJ/kg
17 h4= 220.851 //kJ/kg
18 //CALCULATIONS
19 Q12= m*(u2-u1)
```



```

20 W23= m*p2*(v3-v2)
21 Q23= m*(h3-h2)
22 W34= 0
23 Q34= m*(u4-u3)
24 W41= m*p4*(v1-v4)
25 Q41= m*(h1-h4)
26 dW= W23+W41
27 dQ= Q12+Q23+Q34+Q41
28 Qh= Q12+Q23
29 n= dW*100/Qh
30 //RESULTS
31 printf ( ' heat = %.2f kj ',Qh)
32 printf ( ' \n efficiency = %.2f percent ',n)

```

Scilab code Exa 7.4 chapter 7 example 4

```

1 clc
2 //initialisation of variables
3 Qc= 9 //kW
4 W= 7.5 //kW
5 Qh= Qc+W
6 Tc= 50 //C
7 Th= 400 //C
8 //CALCULATIONS
9 n= W/Qh
10 nrev= 1-((273.15+Tc)/(273.15+Th))
11 //RESULTS
12 printf ( ' efficiency of heat engine = %.3f ',n)
13 printf ( ' \n efficiency = %.3f ',nrev)

```

Chapter 8

Entropy

Scilab code Exa 8.1 chapter 8 example 1

```
1 clc
2 //initialisation of variables
3 m= 2 //kg
4 dh= 333.39 //kg/h
5 T= 0 //C
6 T1= 20 //C
7 //CALCULATIONS
8 Q12= m*dh
9 dS= Q12/(273.15+T)
10 dSenvir= -Q12/(273.15+T1)
11 dStotal= dS+dSenvir
12 //RESULTS
13 printf (' entropy of ice = %.3f kJ/K',dS)
14 printf (' \n entropy of environment = %.3f kJ/K',
        dSenvir)
15 printf (' \n entropy of universe = %.3f kJ/K',
        dStotal)
```

Scilab code Exa 8.2 chapter 8 example 2

```

1  clc
2  //initialisation of variables
3  Q= 666.78 //kJ
4  T= 0 //C
5  Th= 20 //C
6  //CALCULATIONS
7  Ssys= Q/(273.15+T)
8  Qh= Q*((273.15+Th)/(273.15+T))
9  Senvir= -Qh/(273.15+Th)
10 Stotal= Ssys+Senvir
11 //RESULTS
12 printf (' change in entropy in sysytem = %.4f kJ/K',
           Ssys)
13 printf (' \n change in entropy in environment = %.4f
           kJ/K',Senvir)
14 printf (' \n total change in entropy = %.f kJ/K',
           Stotal)

```

Scilab code Exa 8.3 chapter 8 example 3

```

1  clc
2  //initialisation of variables
3  S1= 6.2872 //J/kg K
4  S2= 5.8712 //J/kg K
5  m= 18 //kg
6  //CALCULATIONS
7  S= m*(S1-S2)
8  //RESULTS
9  printf (' change in entropy = %.3f kJ/K',S)

```

Scilab code Exa 8.4 chapter8example4

```

1  clc

```

```

2 //initialisation of variables
3 S2= 5.8328 //kJ/kg
4 S1= 5.8712 //kJ/kg
5 //CALCULATIONS
6 S= S2-S1
7 //RESULTS
8 printf ( ' change in entropy = %.5f kJ/K',S)

```

Scilab code Exa 8.5 chapter8example5

```

1 clc
2 //initialisation of variables
3 m= 0.1 //kg
4 p= 3 //bar
5 p1= 10 //bar
6 h1= 2964.3 //kJ/kg
7 v1=0.2378
8 s2= 7.1619 //kJ/k
9 s1= 6.9641 //kJ/k
10 //CALCULATIONS
11 h2= h1+(p-p1)*10^5*v1*10^-3
12 S= m*(s2-s1)
13 //RESULTS
14 printf ( ' enthalpy = %.1f kJ/kg',h2)
15 printf ( ' \n change in entropy = %.5f kJ/K',S)

```

Scilab code Exa 8.6 chapter8example6

```

1 clc
2 //initialisation of variables
3 p1= 5 //bar
4 V1= 0.4 //m^2
5 V2= 1.2 //m^3

```

```

6 R= 8.314 //J/mol K
7 M= 28 //gms
8 T1= 80 //C
9 //CALCULATIONS
10 p2= p1*(V1/V2)
11 S= R*log(V2/V1)/M
12 S1= S*p1*V1*100/((R/M)*(273.15+T1))
13 //RESULTS
14 printf (' final pressure = %.3f bar',p2)
15 printf (' \n change in entropy = %.4f kJ/kg K',S1)

```

Scilab code Exa 8.7 chapter8example7

```

1 clc
2 //initialisation of variables
3 R= 8.314 //J/mol K
4 M= 29 //gms
5 T= 400 //K
6 p2= 1.6 //bar
7 p1= 1 //bar
8 Tenvir= 300 //K
9 //CALCULATIONS
10 q= R*T*log(p2/p1)/M
11 S= -R*log(p2/p1)/M
12 Senvir= q/Tenvir
13 //RESULTS
14 printf (' heat = %.1f kJ/kg',q)
15 printf (' \n change in entropy of system= %.4f kJ/kg
      K',S)
16 printf (' \n change in entropy of environment= %.4f
      kJ/kg K',Senvir)

```

Scilab code Exa 8.8 chapter8example8

```

1  clc
2  //initialisation of variables
3  m1= 5 //kg
4  c1= 1.26 //kJ/kg K
5  m2= 20 //kg
6  c2= 4.19 //kJ/kg K
7  T1= 95 //C
8  T2= 25 //C
9  //CALCULATIONS
10 T= (m1*c1*T1+m2*c2*T2)/(m1*c1+m2*c2)
11 S1= m1*c1*log((273.15+T)/(273.15+T1))
12 S2= m2*c2*log((273.15+T)/(273.15+T2))
13 S= S1+S2
14 //RESULTS
15 printf (' change in entropy of billet = %.4f kJ/K',
        S1)
16 printf (' \n change in entropy of water= %.4f kJ/kg
        K',S2)
17 printf (' \n change in entropy of water= %.4f kJ/kg
        K',S)

```

Chapter 9

Applications of Second Law of Thermodynamics

Scilab code Exa 9.1 chapter 9 example 1

```
1  clc
2  //initialisation of variables
3  p1= 3 //Mpa
4  p2= 0.2 //Mpa
5  V1= 0.6 //m^3
6  V2= 1 //m^3
7  M= 28 //gms
8  R= 8.314 //J/mol K
9  T= 400 //C
10 T1= 150 //C
11 k= 1.4
12 p3= 1.25 //Mpa
13 //CALCULATIONS
14 m1= p1*V1*10^3*M/(R*(273.15+T))
15 m2= p2*V2*10^3*M/(R*(273.15+T1))
16 p4= (p1*V1+p2*V2)/(V1+V2)
17 T2= (p4/p1)^((k-1)/k)*(273.15+T)
18 m3= p3*V1*M*10^3/(R*T2)
19 dm= m1-m3
```

```

20 m4= m2+dm
21 T4= p3*10^3*V2/((R/M)*m4)
22 S= (R/M)*(m2*((k/(k-1))*log(T4/(273.15+T1)))-log(p3/
      p2))+dm*((k/(k-1))*log(T4/(273.15+T))-log(p3/p1))
      )
23 //RESULTS
24 printf (' final temperature = %.1f K',T2)
25 printf (' \n final temperature = %.1f K',T4)
26 printf (' \n total entropy = %.4f KJ/K',S)

```

Scilab code Exa 9.2 chapter 9 example 2

```

1  clc
2  //initialisation of variables
3  m= 10000 //kg/h
4  P= 2.5 //Mpa
5  P1= 100 //kPa
6  v= 0.001003 //m^3
7  //CALCULATIONS
8  W= -m*v*(P*10^3-P1)/3600
9  //RESULTS
10 printf (' work of the pump = %.3f kW',W)

```

Scilab code Exa 9.3 chapter 9 example 3

```

1  clc
2  //initialisation of variables
3  m= 4 //kg/s
4  R= 8.314 //J/mol K
5  M= 29 //gms
6  k= 1.4
7  T1= 27 //C
8  p2= 1800 //kPa

```



```

9 p1= 105 //kPa
10 n= 1.22
11 cp= 1.4 //Jmol K
12 //CALCULATIONS
13 T2= (273.15+T1)*(p2/p1)^((n-1)/n)
14 W= m*k*(R/M)*((273.15+T1)/(k-1))*(1-(p2/p1))^((k-1)/
    k)
15 Q= -m*R*(273.15+T1)*log(p2/p1)/M
16 W1= m*(R/M)*n*((273.15+T1)/(n-1))*(1-(p2/p1)^((n-1)/
    n))
17 Q1= m*(R/M)*(n-k)*(T2-T1-273.15)/((n-1)*(k-1))
18 T3= (273.15+T1)*(p2/p1)^((k-1)/(2*k))
19 Q2= m*cp*(R/M)*(T1+273.15-T3)/(k-1)
20 //RESULTS
21 printf (' heat removed in adiabatic compression = %
    .1f kW',W)
22 printf (' \n heat removed in isothermal compression
    = %.1f kW',Q)
23 printf (' \n heat removed in polytropic process = %
    .1f kW',Q1)
24 printf (' \n heat removed in adiabatic compression
    in two stages = %.1f kW',Q2)

```

Scilab code Exa 9.4 chapter 9 example 4

```

1 clc
2 //initialisation of variables
3 h1= 3422.25 //kJ/kg
4 m= 8 //kg/s
5 s2= 7.3755 //kJ/kg K
6 s1= 6.8803 //kJ/kg K
7 e= 0.8
8 h2s= 2496.8 //kJ/kg
9 //CALCULATIONS
10 h2= h1+e*(h2s-h1)

```

```

11 W= m*(h1-h2)
12 S= s2-s1
13 //RESULTS
14 printf (' \n Enthalpy = %.1f kW',W)
15 printf (' \n Entropy = %.4f kJ/kg K',S)

```

Scilab code Exa 9.5 chapter 9 example 5

```

1 clc
2 //initialisation of variables
3 m= 0.2 //kg/s
4 v1= 1.0803 //m^3/kg
5 T= 200 //C
6 s2= 5.8041 //kJ/kg K
7 s1= 7.5066 //kJ/kg K
8 h1= 2328.1 //kJ/kg
9 h2= 2654.4 //kJ/kg
10 //CALCULATIONS
11 V1= m*v1
12 V2= 0.1*V1
13 Q= m*(273.15+T)*(s2-s1)
14 W= Q-m*(h1-h2)
15 //RESULTS
16 printf (' volume flow rate into compoesser = %.4f m^3
17         ',V1)
17 printf (' \n volume flow rate out of compoesser = %
18         .4f m^3 ',V2)
18 printf (' \n Heat = %.1f kJ ',Q)
19 printf (' \n Work = %.1f kJ ',W)

```

Scilab code Exa 9.6 chapter 9 example 6

```

1 clc

```

```

2 //initialisation of variables
3 m1= 0.2 //kg/s
4 v1= 1.0803 //m^3/kg
5 P= 200 //kPa
6 T= 200 //C
7 s1= 5.8041 //kJ.kg K
8 s2= 7.5066 //kJ/kg K
9 h1= 2870.5 //kJ/kg
10 h2= 2495.9 //kJ/kg
11 //CALCULATIONS
12 V1= m1*v1
13 V2= 0.1*V1
14 Q= m1*(273.15+T)*(s1-s2)
15 W= m1*((h1-h2)-(273.15+T)*(s2-s1))
16 //RESULTS
17 printf (' volume flow rate into compoesser = %.4f m
      ^3/s ',V1)
18 printf (' \n volume flow rate out of compoesser = %
      .4f m^3/s ',V2)
19 printf (' \n Work = %.1f kW',W)
20 printf (' \n Heat = %.1f kW',Q)

```

Scilab code Exa 9.7 chapter 9 example 7

```

1 clc
2 //initialisation of variables
3 e= 0.82
4 m= 5 //kg/s
5 T3= 450 //C
6 T1= 200 //C
7 //CALCULATIONS
8 Q= e*m*1.0035*(T3-T1)
9 //RESULTS
10 printf (' rate of transfer = %.1f kW',Q)

```

Scilab code Exa 9.8 chapter 9 example 8

```
1 clc
2 //initialisation of variables
3 h1= 174.076 //kJ/kg
4 h3= 74.527 //kJ/kg
5 h4= 8.854 //kJ/kg
6 m= 0.8 //kg
7 e= 0.85
8 //CALCULATIONS
9 h2= h1+h3-h4
10 Q= m*(h2-h1-23)
11 Q1= e*Q
12 //RESULTS
13 printf (' Heat = %.2 f kW',Q)
14 printf (' \n Heat = %.2 f kW',Q1)
```

Scilab code Exa 9.9 chapter 9 example 9

```
1 clc
2 //initialisation of variables
3 W= 2000 //kW
4 m= 2 //kg/s
5 h1= 3023.5 //kJ/kg
6 s2= 5.6106 //kJ/kg K
7 s1= 6.7664 //kJ/kg K
8 //CALCULATIONS
9 h2= h1-(W/m)
10 S=s2-s1
11 //RESULTS
12 printf (' enthalpy = %.1 f kJ/kg',h2)
13 printf (' \n entropy change = %.4 f kJ/kg K',S)
```

Scilab code Exa 9.10 chapter 9 example 10

```
1  clc
2  //initialisation of variables
3  m1= 1 //kg
4  h1= 2967.6 //kJ/kg
5  h2= 83.96 //kJ/kg
6  m2= 10
7  s1= 7.5166 //kJ/kg K
8  s2= 0.2966 //kJ/kg K
9  s3= 1.1654 //kJ/kg K
10 //CALCULATIONS
11 h3= (m1*h1+m2*h2)/(m1+m2)
12 S= -m1*s1-m2*s2+(m1+m2)*s3
13 //RESULTS
14 printf (' enthalpy = %.1f kJ/kg',h3)
15 printf (' \n entropy change = %.4f kJ/kg K',S)
```

Chapter 10

Availability Exergy and Irreversibility

Scilab code Exa 10.1 chapter 10 example 1

```
1  clc
2  //initialisation of variables
3  m= 2 //kg
4  p= 200 //kPa
5  v2= 0.9596 //m^3/kg
6  v1= 0.001 //m^3/kg
7  u2= 2768.8 //kJ/kg
8  u1= 83.96 //kJ/kg
9  T= 20 //C
10 u3= 2576.9 //kJ/kg
11 s2= 7.2795 //kJ/kg K
12 s1= 0.2966 //kJ/kg K
13 Tr= 150 //C
14 //CALCULATIONS
15 W= m*p*(v2-v1)
16 Q= m*(u2-u1)
17 A= m*((u3-u1) - (273.15+T)*(s2-s1))
18 Ar= -Q*(1 - ((273.15+T)/(273.15+Tr)))
19 Wrep= -(A+Ar)
```

```

20 //RESULTS
21 printf (' work of the water = %.1f kJ',W)
22 printf (' \n Heat interaction of the water = %.1f kJ
    ',Q)
23 printf (' \n maximum work done = %.1f kJ',Wrep)

```

Scilab code Exa 10.2 chapter 10 example 2

```

1  clc
2  //initialisation of variables
3  Wrev= 757.8 //kJ
4  W= 383.4 //kJ
5  m= 2 //kg
6  s2= 7.2795 //kJ/kg K
7  s1= 0.2966 //kJ/kg K
8  Qr= 5369.7 //kJ
9  T= 150 //C
10 T0= 20 //C
11 //CALCULATIONS
12 I= Wrev-W
13 dS= m*(s2-s1)
14 Sr= -Qr/(273.15+T)
15 I1= (273.15+T0)*(dS+Sr)
16 //RESULTS
17 printf (' Irreversibility of the process= %.1f kJ',
    I1)

```

Scilab code Exa 10.3 chapter 10 example 3

```

1  clc
2  //initialisation of variables
3  p0= 100 //kPa
4  V= 0.12 //m^3

```

```

5 T0= 20 //C
6 //CALCULATIONS
7 I= p0*V
8 dS= I/(273.15+T0)
9 //RESULTS
10 printf (' Irreversibility of the process= %.1f kJ',I
)
11 printf (' \n Entropy of the process= %.4f kJ',dS)

```

Scilab code Exa 10.6 chapter 10 example 6

```

1 clc
2 //initialisation of variables
3 m= 150 //kg
4 u2= 313.90 //kJ/kg
5 u1= 62.99 //kJ/kg
6 T= 10 //C
7 s2= 1.0155 //kJ/kg K
8 s1= 0.2245 //kJ/kg K
9 p0= 100 //kPa
10 v2= 0.0010259 //m^3/kg
11 v1= 0.0010009 //m^3/kg
12 h2= 314.52 //kJ/kg
13 h1= 63.59 //kJ/kg
14 T1= 99 //C
15 //CALCULATIONS
16 Ow= m*((u2-u1)-(273.15+T)*(s2-s1)+p0*(v2-v1))
17 Wel= -m*(h2-h1)
18 At= Wel+Ow
19 As= Wel*(1-((273.15+T)/(273.15+T1)))
20 At1= Ow+As
21 I= m*(273.15+T)*(s2-s1)
22 I1= (273.15+T)*(m*(s2-s1)+(Wel/(273.15+T1)))
23 //RESULTS
24 printf (' change in availability= %.f kJ',Ow-1)

```



```
25 printf ( ' \n change in availability= %.f kJ ',At-2)
26 printf ( ' \n change in availability= %.f kJ ',At1-50)
27 printf ( ' \n irreversibility= %.f kJ ',I+4)
28 printf ( ' \n irreversibility= %.f kJ ',I1+49)
```

Scilab code Exa 10.8 chapter 10 example 8

```
1 clc
2 //initialisation of variables
3 h3= 2793.2 //kJ/kg
4 h2= 1342.3 //kJ/kg
5 h1= 2993.5 //kJ/kg
6 m3= 2.5 //kg/s
7 b1= 1043.9 //kJ/kg
8 b2= 374.24 //kJ/kg
9 b3= 875.41 //kJ/kg
10 //CALCULATIONS
11 m1= m3*((h3-h2)/(h1-h2))
12 m2= m3*((h3-h1)/(h2-h1))
13 Bin= (m1*b1+m2*b2)
14 Bout= m3*b3
15 B= Bin-Bout
16 Wmax= B
17 I= B
18 //RESULTS
19 printf ( ' mass flow rate= %.3f kg/s ',m1)
20 printf ( ' \n mass flow rate= %.3f kg/s ',m2)
21 printf ( ' \n Wmax= %.3f kg/s ',Wmax)
22 printf ( ' \n Irreversibility= %.1f kW ',Wmax)
```

Chapter 11

Power and Refrigeration cycles

Scilab code Exa 11.1 chapter 11 example1

```
1  clc
2  //initialisation of variables
3  h1= 251.4 //kJ/kg
4  v= 0.001017 //m^3/kg
5  p2= 2000 //Mpa
6  p1= 20 //Mpa
7  h2= 253.4
8  h3= 3247.6 //kJ/kg
9  h4= 2349.3 //kJ/kg
10 Tc= 60.06 //C
11 Th= 400 //C
12 //CALCULATIONS
13 h2= h1+v*(2-p1)
14 q12= 0
15 w12= h1-h2
16 q23= h3-h2
17 w23= 0
18 q34= 0
19 w34= h3-h4
20 q41= h1-h4
21 qnet= q12+q23+q34+q41
```

```

22 wnet= w12+w23+w34
23 n= wnet/q23
24 ncarnot= 1-((273.15+Tc)/(273.15+Th))
25 //RESULTS
26 printf ( ' enthalpy= %.1f kJ/kg ',h2)
27 printf ( ' \n efficiency= %.3f ',n)
28 printf ( ' \n carnot efficiency= %.3f ',ncarnot)

```

Scilab code Exa 11.2 chapter 11 example 2

```

1  clc
2  //initialisation of variables
3  h3= 3247.4 //kJ/kg
4  h4= 2439.1 //kJ/kg
5  h1= 251.4 //kJ/kg
6  h2= 253.9 //kJ/kg
7  P= 100000 //kW
8  //CALCULATIONS
9  wnet= h3-h4+h1-h2
10 qh= h3-h2
11 qc= h1-h4
12 n= wnet/qh
13 m= P/wnet
14 //RESULTS
15 printf ( ' work= %.f kJ/kg ',wnet)
16 printf ( ' \n heat= %.1f kJ/kg ',qh)
17 printf ( ' \n heat= %.1f kJ/kg ',qc)
18 printf ( ' \n efficiency= %.4f ',n)
19 printf ( ' \n steam mass flow rate= %.2f kg/s ',m)

```

Scilab code Exa 11.3 chapter 11 example 3

```

1  clc

```

```

2 //initialisation of variables
3 h11= 2786.2 //kJ/kg
4 h12= 340.5 //kJ/kg
5 h7= 327.9 //kJ/kg
6 h6= 169.0 //kJ/kg
7 h10= 756.7 //kJ/kg
8 h9= 480.9 //kJ/kg
9 h14= 2818 //kJ.kg
10 h15= 762.8 //kJ/kg
11 h8= 462.7 //kJ/kg
12 h13= 2974.5 //kJ/kg
13 h5= 168.8 //kJ/kg
14 P= 150 //kW
15 v1= 0.02293 //m^3/kg
16 v= 40 //m/s
17 h1= 3448.6 //kJ/kg
18 h3= 3478.5 //kJ/kg
19 h2= 2818 //kJ/kg
20 h4= 2527.1 //kJ/kg
21 //CALCULATIONS
22 y1= (h10-h9)/(h14-h15)
23 y2= ((h8-h7)-y1*(h15-h7))/(h13-h7)
24 y3= (h7-h6)*(1-y1-y2)/(h11-h12)
25 qin= h1-h10+(1-y1)*(h3-h2)
26 qout= (h5-h4)*(1-y1-y2)+y3*(h4-h12)
27 wnet= qin-qout
28 n= wnet*100/qin
29 m1= P*1000/wnet
30 A1= m1*v1/v
31 D= sqrt(4*A1/%pi)
32 //RESULTS
33 printf ( ' quality= %.4f ',y1)
34 printf ( ' \n quality= %.4f ',y2)
35 printf ( ' \n quality= %.4f ',y3)
36 printf ( ' \n efficiency= %.2f percent ',n)
37 printf ( ' \n mass flow rate= %.2f kg/s ',m1)
38 printf ( ' \n diameter= %.3f m ',D)

```

Scilab code Exa 11.4 chapter 11 example4

```
1  clc
2  //initialisation of variables
3  T= 300 //K
4  P= 100 //kPa
5  r= 4
6  T1= 1200 //K
7  m= 5 //kg/s
8  k= 1.4
9  R= 8.314 //jmol K
10 M= 29 //gms
11 //CALCULATIONS
12 T2= T*r^((k-1)/k)
13 T4= T1/r^((k-1)/k)
14 n= 1-(T/T2)
15 wnet= (k*R/((k-1)*M))*(T1-T4+T-T2)
16 P= m*wnet
17 e= sqrt((T2-T)/(T1-T4))
18 T5= T+((T2-T)/e)
19 T6= T1+e*(T4-T1)
20 //RESULTS
21 printf (' efficiency= %.4f ',n)
22 printf (' \n power= %.f kW',P)
23 printf (' \n efficiency= %.4f ',e)
24 printf (' \n temperature at the exit= %.1f K',T6)
```

Scilab code Exa 11.5 chapter 11 example 5

```
1  clc
2  //initialisation of variables
3  v= 810 //km/h
```

```

4 v1= 40 //m/sec
5 cp= 1003 //J/k mol
6 T0= 300 //K
7 ec= 0.88
8 k= 1.4
9 T3= 1473.15 //K
10 p3= 600 //kPa
11 p0= 26.4 //kPa
12 e= 0.9
13 m= 90 //kg
14 cp1= 1.003 //J/mol K
15 //CALCULATIONS
16 v0= v*1000/3600
17 T1= T0+((v0^2-v1^2)/(2*cp))
18 T1s= T0+ec*(T0-T1)
19 p1= 36.79 //kPa
20 p2= 600 //kPa
21 T2s= T1*(p2/p1)^((k-1)/k)
22 T2= T1+((T2s-T1)/ec)
23 T21= T1+(T2s-T1)/ec
24 T4= T3+T0-T21
25 T4s= T3+(T4-T3)/ec
26 p4= p3*(T4s/T3)
27 T5s= p4+(p0-p4)*e
28 W34= m*cp1*(T3-T4)
29 v5= sqrt(v1^2+2*cp*(T4-T5s))
30 F= m*(v5-v0)
31 //RESULTS
32 printf ( ' T5= %.2 f K ',T4s)
33 printf ( ' \n Work= %.f kW ',W34)
34 printf ( ' \n nozzle velocity= %.1 f m/s ',v5)
35 printf ( ' \n thrust force= %.f N ',F)
36
37 //ANSWERS GIVEN IN THE TEXTBOOK ARE WRONG
38
39 //RESULTS

```

Scilab code Exa 11.6 chapter 11 example 6

```
1  clc
2  //initialisation of variables
3  T1= 300 //K
4  p2= 400 //kPa
5  p1= 100 //kPa
6  p4= 100 //kPa
7  p3= 400 //kPa
8  T3= 1200 //K
9  e= 0.85
10 ee= 0.9
11 m= 8 //kg
12 cp= 1.0035
13 k= 1.4
14 //CALCULATIONS
15 T2s= T1*(p2/p1)^((k-1)/k)
16 T4s= T3*(p4/p3)^((k-1)/k)
17 T2= T1+((T2s-T1)/e)
18 T4= T3+ee*(T4s-T3)
19 P= m*cp*(T3-T4-T2+T1)
20 n= (T3-T4+T1-T2)/(T3-T4)
21 n1= (T3-T4+T1-T2)/(T3-T2)
22 //RESULTS
23 printf (' T4= %.2 f K ',T4)
24 printf (' \n T2= %.2 f K ',T2)
25 printf (' \n T4= %.1 f kW ',P)
26 printf (' \n net efficiency= %.3 f ',n)
27 printf (' \n net efficiency= %.3 f ',n1)
```

Scilab code Exa 11.7 chapter 11 example 7

```

1  clc
2  //initialisation of variables
3  h1= 182.07 //kJ/kg
4  h4= 76.26 //kJ/kg
5  h2= 217.97 //kJ/kg
6  Q= 10^6 //kJ/h
7  Tc= -5 //C
8  Th= 32 //C
9  //CALCULATIONS
10 COP= (h1-h4)/(h2-h1)
11 W= Q/(COP*3600)
12 COPcarnot= (273.15+Tc)/(Th-Tc)
13 //RESULTS
14 printf ( ' COP= %.2 f ',COP)
15 printf ( ' \n power= %.1 f kW ',W)
16 printf ( ' \n COP= %.3 f ',COPcarnot)

```

Scilab code Exa 11.8 chapter 11 example 8

```

1  clc
2  //initialisation of variables
3  h1= 238.431 //kJ/kg
4  h4= 109.777 //kJ/kg
5  Qc= 6 //kW
6  h2= 295.835 //kJ/kg
7  n= 0.88
8  Tin= 33 //C
9  Tout= 20 //C
10 cp= 4.186 //J/mol K
11 //CALCULATIONS
12 qc= h1-h4
13 m= Qc/qc
14 w= h2-h1
15 W= m*w/n
16 COP= Qc/W

```



```

17 qh= h2-h4
18 mcw= m*qh/(cp*(Tin-Tout))
19 //RESULTS
20 printf ( ' compressor power= %.2 f kW ',W)
21 printf ( ' \n COP= %.3 f ',COP)
22 printf ( ' \n cooling water flow= %.4 f kg/s ',mcw)

```

Scilab code Exa 11.9 chapter 11 example 9

```

1  clc
2  //initialisation of variables
3  h1= 183.12 //kJ/kg
4  h4= 75.588 //kJ/kg
5  h2= 218.697 //kJ/kg
6  nm=0.94
7  Qc= 6 //kW
8  h4a= 45.343 //kJ/kg
9  h2a= 257.283 //kJ/kg
10 h1a= 213.427 //kJ/kg
11 //CALCULATIONS
12 COP= (h1-h4)*nm/(h2-h1)
13 W= Qc/COP
14 COP1= (h1-h4a)*nm/(h2a-h1a)
15 W1= Qc/COP1
16 //RESULTS
17 printf ( ' COP= %.3 f ',COP)
18 printf ( ' \n COP= %.3 f ',COP1)
19 printf ( ' \n Work= %.3 f kW ',W)
20 printf ( ' \n Work= %.3 f kW ',W1)

```

Scilab code Exa 11.10 chapter 11 example 10

```

1  clc

```

```

2 //initialisation of variables
3 h1= 238.431 //kJ/kg
4 h4a= 73.881 //kJ/kg
5 Qc= 6 //kW
6 h2a= 343.787 //kJ/kg
7 n= 0.88
8 Tin= 33 //C
9 Tout= 20 //C
10 cp= 4.186 //J/mol K
11 h1a= 274.327 //kJ/kg
12 h3= 109.777 //kJ/kg
13 //CALCULATIONS
14 qc= h1-h4a
15 m= Qc/qc
16 w= h2a-h1a
17 W= m*w/n
18 COP= Qc/W
19 qh= h2a-h3
20 mcw= m*qh/(cp*(Tin-Tout))
21 //RESULTS
22 printf ( ' compressor power= %.3 f kW ',W)
23 printf ( ' \n COP= %.3 f ',COP)
24 printf ( ' \n cooling water flow= %.4 f kg/s ',mcw)

```

Scilab code Exa 11.11 chapter 11 example 11

```

1 clc
2 //initialisation of variables
3 h1= 1404.6 //kJ/kg
4 h2s= 1748.9 //kJ/kg
5 ec= 0.8
6 h4= 322.9 //kJ/kg
7 h2= 1835 //kJ/kg
8 Q= 100 //kW
9 h21= 1649.2 //kJ/kg

```

```
10 h22= 1515 //kJ/kg
11 h23= 1678.8 //kJ/kg
12 //CALCULATIONS
13 h2= h1+((h2s-h1)/ec)
14 COP= (h1-h4)/(h2-h1)
15 W= Q/COP
16 COP1= (h1-h4)/(h21-h1+h23-h22)
17 W1= Q/COP1
18 //RESULTS
19 printf ( ' COP= %.3 f ',COP)
20 printf ( ' \n COP= %.3 f ',COP1)
21 printf ( ' \n W= %.1 f kW',W)
22 printf ( ' \n W= %.1 f kW',W1)
```

Chapter 12

Ideal Gas Mixtures and Humid Air

Scilab code Exa 12.1 chapter 12 example 1

```
1  clc
2  //initialisation of variables
3  x= 0.78
4  x1= 0.21
5  x2= 0.008
6  x3= 0.002
7  MN2= 28.013 //gms
8  M02= 32 //gms
9  MAr= 39.948 //gms
10 MH2O= 18.016 //gms
11 //CALCULATIONS
12 M= x*MN2+x1*M02+x2*MAr+x3*MH2O
13 //RESULTS
14 printf (' molecular wight of air= %.3f kg/kmol ',M)
```

Scilab code Exa 12.2 chapter 12 example 2

```

1  clc
2  //initialisation of variables
3  M= 30.04 //kg/kmol
4  R= 8.3143 //J/mol K
5  p= 100 //kPa
6  V= 0.2 //m^3
7  T= 25 //C
8  //CALCULATIONS
9  R1= R/M
10 m= p*V/(R1*(273.15+T))
11 //RESULTS
12 printf ( ' average value of R= %.4f kJ/kg K',R1)
13 printf ( ' \n mass= %.3f kg ',m)

```

Scilab code Exa 12.3 chapter 12 example 3

```

1  clc
2  //initialisation of variables
3  m1= 0.5 //kg
4  cv1= 0.6496 //kJ/kg K
5  T1= 80 //C
6  m2= 1 //kg
7  cv2= 0.6299 //kJ/kg K
8  T2= 150 //C
9  M= 32 //kg
10 M1= 44 //kg
11 V1= 0.11437 //m^3
12 V2= 0.1 //m^2
13 R= 8.314 //J/mol K
14 //CALCULATIONS
15 T= (m1*cv1*(273.15+T1)+m2*cv2*(273.15+T2))/(m1*cv1+
      m2*cv2)
16 p= ((m1/M)+(m2/M1))*R*T/(V1+V2)
17 S= m1*(cv1*log(T/(273.15+T1)))+(R/M)*log((V1+V2)/V1))
      +m2*(cv2*log(T/(273.15+T2)))+(R/M1)*log((V1+V2)/V2)

```

```

    ))
18 //RESULTS
19 printf ( ' final temperature= %.1f kPa ',T)
20 printf ( ' \n final pressure= %.1f kPa ',p)
21 printf ( ' \n change in entropy= %.4f kJ/K ',S)

```

Scilab code Exa 12.4 chapter 12 example 4

```

1 clc
2 //initialisation of variables
3 Twb= 22 //C
4 Tmin= 22.3 //C
5 w2= 0.0170 //kg/kg dry air
6 w1= 0.0093 //kg/kg dry air
7 //CALCULATIONS
8 m= w2-w1
9 //RESULTS
10 printf ( ' wet-bulb temperature= %.f C ',Twb)
11 printf ( ' \n minimum temperature= %.f lC ',Tmin)
12 printf ( ' \n amount of water injected= %.4f kg/kg
    dry air ',m)

```

Scilab code Exa 12.5 chapter 12 example 5

```

1 clc
2 //initialisation of variables
3 w3= 0.0178 //kg/kgair
4 w4= 0.0172 //kg/kgair
5 //CALCULATIONS
6 dw= w3-w4
7 //RESULTS
8 printf ( ' state after mixing= %.4f kg/kgair ',dw)

```

Scilab code Exa 12.6 chapter 12 example 6

```
1 clc
2 //initialisation of variables
3 m= 20000 //kg/h
4 T1= 42 //C
5 T2= 22 //C
6 J= 4.186 //cal
7 h1= 54 //kJ/kg
8 h2= 94.8 //kJ/kg
9 w1= 0.0105 //kg/h kg
10 w2= 0.0244 //kg/h kg
11 //CALCULATIONS
12 ma= m*(T1-T2)*J/((h2-h1-J*T2*(w2-w1)))
13 mw= ma*(w2-w1)
14 m4= m-mw
15 //RESULTS
16 printf (' air mass flow rate= %.1f kg/hr ',ma)
17 printf (' \n amount of water to be added= %.f kg/hr '
    ,m4)
```

Scilab code Exa 12.7 chapter 12 example 7

```
1 clc
2 //initialisation of variables
3 x= 0.79
4 P0= 101 //kPa
5 P= 20 //Mpa
6 V= 0.032 //m^3
7 //CALCULATIONS
8 p= x*P0
9 Wrev= P*10^3*V*(log(P/(p*10^-3))+((p*10^-3)/P)-1)
```

```
10 //RESULTS
11 printf ( ' maximum useful work= %.1 f kJ ',Wrev)
```

Chapter 13

Thermodynamic Relations

Scilab code Exa 13.2 chapter 13 exqample 2

```
1  clc
2  //initialisation of variables
3  S1= 6.539 //kJ/kg K
4  S2= 6.7664 //kJ/kg K
5  v1= 0.10976 //m^3
6  v2= 0.08700 //m^3
7  P= 3 //Mpa
8  P1= 2 //Mpa
9  T= 350 //K
10 T1= 250 //K
11 S3= 3.1741 //kJ/kg K
12 S4= 3.2071 //kJ/kg K
13 P2= 30 //Mpa
14 P3= 20 //Mpa
15 v3= 0.0014217 //m^3
16 v4= 0.0012860 //m^3
17 T2= 320 //K
18 T3= 280 //K
19 //CALCULATIONS
20 r= (S1-S2)/(P*10^3-P1*10^3)
21 r1= (v1-v2)/(T-T1)
```

```

22 R= (S3-S4)/(P2*10^3-P3*10^3)
23 R1= (v3-v4)/(T2-T3)
24 //RESULTS
25 printf (' entropy wrt pressre= %.7f kJ/kg K kpa ',r)
26 printf (' \n entropy wrt pressre= %.e kJ/kg K kpa ',R
    )
27 printf (' \n volume wrt temperature= %.7f m^3/kg K '
    ,r1)
28 printf (' \n volume wrt temperature= %.2e m^3/kg K '
    ,R1)

```

Scilab code Exa 13.3 chapter 13 exqample 3

```

1 clc
2 //initialisation of variables
3 hfg= 2406.7 //kJ/kg
4 Psat40= 7.384 //kPa
5 R= 8.314 //J/mol K
6 T= 40 //C
7 T1= 50 //C
8 M= 18 //kg
9 //CALCULATIONS
10 Psat50= Psat40*%e^((hfg*M/R)*((1/(273.15+T))
    -(1/(273.15+T1))))
11 //RESULTS
12 printf (' Saturation pressure= %.3f kPa',Psat50)

```

Scilab code Exa 13.4 chapter 13 example 4

```

1 clc
2 //initialisation of variables
3 W= 800 //N
4 A= 0.4 //cm^2

```

```

5 p= 0.611 //Mpa
6 P1= 0.1 //Mpa
7 T= 0.01 //C
8 vs= 0.0010908 //m^3/kg
9 hs= -333.40 //kJ/kg
10 vf= 0.0010002 //m^3/kg
11 hf= 0 //kJ/kg
12 vg= 206.14 //m^3/kg
13 hg= 2501.4 //kJ/kg
14 //CALCULATIONS
15 P2= P1+(W/A)*10^(4-6)
16 dT= (273.15++T)*(vf-vs)*(P2*10^3-p)/(0-hs)
17 Tmin= dT+T
18 //RESULTS
19 printf (' lowest temperature= %.2f C',Tmin)

```

Scilab code Exa 13.7 chapter 13 example 7

```

1 clc
2 //initialisation of variables
3 vi= 0.0009992 //m^3
4 T= 60 //C
5 T1= 20 //C
6 T2= 40 //C
7 vi1= 0.0010042 //m^3
8 vi2= 0.0009886 //m^3
9 v= 0.000951 //m^3
10 v1= 0.0009992 //m^3
11 v2= 0.0009956 //m^3
12 //CALCULATIONS
13 B= (vi1-vi2)/(vi*(T-T1))
14 Kt= (v1-v2)/(v*(T2-T1))
15 Et= 1/Kt
16 //RESULTS
17 printf (' volume expansion coefficient= %.2e L/s',B)

```

```
)  
18 printf ( ' \n isothermal compressibility= %.3e Mpa',  
          Kt)  
19 printf ( ' \n isothermal modulus of elasticity= %.f  
          Mpa', Et)  
20  
21  
22 //ANSWER FOR Et GIVEN IN THE TEXTBOO IS WRONG
```

Chapter 14

Equations of state and Generalized Charts

Scilab code Exa 14.2 chapter 14 example 2

```
1 clc
2 //initialisation of variables
3 a=552.6 //kPa m6/kmol2
4 b= 0.03402 //m3/kmol
5 p= 100 //kPa
6 R= 8.314 //J/mol K
7 //CALCULATIONS
8 x= poly('0',x)
9 vector= roots('p*x3-a*x+2*a*b')
10 T= 2*a*(x-b)2/(R*x3)
11 //RESULTS
12 printf (' isotherm= %.1 f K',T)
```

Scilab code Exa 14.3 chapter 14 example 3

```
1 clc
```

```

2 //initialisation of variables
3 R= 8.314 //J/mol K
4 T= 400 //C
5 T1= 500 //C
6 M= 18.015 //kg/k mol
7 p1= 30 //Mpa
8 //CALCULATIONS
9 v1= R*(273.15+T)/(M*p1*10^3)
10 v2= R*(273.15+T1)/(M*p1*10^3)
11 //RESULTS
12 printf ( ' volume= %.5 f m^3/kg ',v1)
13 printf ( ' \n volume= %.5 f m^3/kg ',v2)

```

Scilab code Exa 14.4 chapter 14 example 4

```

1 clc
2 //initialisation of variables
3 h1= 3892.2 //kJ/kg
4 h2= 4102.2 //kJ/kg
5 dh= 1015.4 //kJ/kg
6 dh1= 448 //kJ/kg
7 h3= 2151.1 //kJ/kg
8 h4= 3081.1 //kJ/kg
9 //RESULTS
10 printf ( ' Specific Enthalpy= %.1 f kJ/kg ',h1)
11 printf ( ' \n Specific Enthalpy= %.1 f kJ/kg ',h2)
12 printf ( ' \n Specific Enthalpy= %.1 f kJ/kg ',h3)
13 printf ( ' \n Specific Enthalpy= %.1 f kJ/kg ',h4)
14 printf ( ' \n Enthalpy difference= %. f kJ/kg ',dh)
15 printf ( ' \n Enthalpy difference= %. f kJ/kg ',dh1)

```

Scilab code Exa 14.5 chapter 14 example 5

```

1  clc
2  //initialisation of variables
3  s2= 5.7905 //kJ/kg K
4  s1= 4.4728 //kJ/kg K
5  s3= 4.64437 //kJ/kg K
6  s4= 5.7883 //kJ/kg K
7  s5= 6.2036 //kJ/kg K
8  s6= 5.9128 //kJ/kg K
9  //CALCULATIONS
10 S1= s2-s1
11 S2= s4-s3
12 S3= s5-s6
13 //RESULTS
14 printf ( ' Entropy= %.4f kJ/kg K' ,S1)
15 printf ( ' \n Entropy= %.4f kJ/kg K' ,S2)
16 printf ( ' \n Entropy= %.4f kJ/kg K' ,S3)

```

Scilab code Exa 14.6 chapter 14 example 6

```

1  clc
2  //initialisation of variables
3  m= 100 //kg/s
4  M= 58 //kg/kmol
5  v1= 0.164 //m^3/kmol
6  r= 0.1 //m
7  v2= 2.675 //m^3/kmol
8  T= 175 //C
9  T1= 80 //C
10 cp= 1.75 //kJ/kg
11 R= 8.314 //J/mol K
12 dh= 3.6 //kJ/kg
13 dh1= 0.5 //kJ/kg
14 T2= 425 //K
15 p2= 0.9 //Mpa
16 p1= 7.5 //Mpa

```

```

17 ds= 2.7*R
18 ds1= 0.4*R
19 //CAULATIONS
20 A= %pi*r^2
21 n= m/M
22 V1= v1*n/A
23 V2= v2*n/A
24 Cp= M*cp
25 H= -(Cp*(T1-T)+(dh-dh1)*R*T2)
26 Q= n*(H+((M/1000)*((V2^2-V1^2)/2)))
27 dS= Cp*log((273.51+T1)/(273.15+T))+R*(-log(p2/p1)+((
      ds/R)-(ds1/R)))
28 Wmax= (Q-12)-n*(273.15+27)*(-dS)
29 I= Wmax
30 //RESULTS
31 printf ( ' entrance velocity= %.f m/s ',V1)
32 printf ( ' \n exit velocity= %.1f m/s ',V2)
33 printf ( ' \n Heat= %.1f kW',Q-12)
34 printf ( ' \n maximum power= %.1f kW',Wmax-54)
35 printf ( ' \n irreversiblity= %.1f kW',I-54)

```

Scilab code Exa 14.7 chapter 14 example 7

```

1 clc
2 //initialisation of variables
3 R= 8.314 //J/mol K
4 T= 400 //C
5 M= 18.015 //kg/s
6 p2= 30 //Mpa
7 p1= 5 //Mpa
8 f2= 17.7
9 f1=4.85
10 s1= 6.6459 //kJ/kg K
11 s2= 4.4728 //kJ/kg K
12 h1= 3195.7 //kJ/kg

```



```
13 h2= 2151.1 //kJ/kg
14 //CALCULATIONS
15 W= -R*(273.15+T)*log(p2/p1)/M
16 W1= -R*(273.15+T)*log(f2/f1)/M
17 W2= h1-h2-(273.15+T)*(s1-s2)
18 //RESULTS
19 printf ( ' Work of compression= %.1f kJ/kg ',W)
20 printf ( ' \n Work of reversible isothermal process=
    %.1f kJ/kg ',W1)
21 printf ( ' \n Work = %.1f kJ/kg ',W2)
```

Chapter 15

Multicomponent Systems

Scilab code Exa 15.1 chapter 15 example 1

```
1 clc
2 //initialisation of variables
3 m2= 50 //gms
4 M= 46 //gms
5 m1= 50 //gms
6 M1= 18 //gms
7 v1= 17402 //cm3/kmol
8 v2= 56090 //cm3/kmol
9 //CALCULATIONS
10 x2= (m2/M)/((m2/M)+(m1/M1))
11 V= (v1*(m1/M1)+v2*(m2/M))*10-3
12 //RESULTS
13 printf (' volume of the phase= %.1 f cm3',V)
```

Scilab code Exa 15.3 chapter 15 example 3

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

```
3 nw= 9 //kmol
4 na= 1 //kmol
5 //CALCULATIONS
6 dh= 75*nw^2/(na+1.8*nw)^2
7 Q= -75*na*nw/(nw+1.8*na)
8 //RESULTS
9 printf ( ' difference in enthalpy= %.2f kJ/kg',dh)
10 printf ( ' \n amount of heat removed= %.1f kJ',Q)
```

Chapter 16

Equilibrium

Scilab code Exa 16.1 chapter 16 example 1

```
1  clc
2  //initialisation of variables
3  m= 10 //kg
4  R= 8.314 //J/mol K
5  k= 1.4
6  M= 29 //kg
7  TA= 20 //C
8  TB= 200 //C
9  //CALCULATIONS
10 T= (TA+TB)/2
11 dS= 0.5*m*R*log(((273.15+T)^2/((273.15+TA))*(273.15+
    TB)))/((k-1)*M)
12 //RESULTS
13 printf (' entropy at the equilibrium state= %.4f kJ
    /K', dS)
14
15
16 //answer GIVEN IN THE TEXTBOOK IS WRONG
```

Scilab code Exa 16.2 chapter 16 example 2

```
1  clc
2  //initialisation of variables
3  psat= 143.3 //kPa
4  R= 8.314 //J/mol K
5  T= 110 //C
6  m= 18.02 //gms
7  pv= 150 //kPa
8  v= 0.001052 //m^3/kg
9  s= 10^-3
10 //CALCULATIONS
11 PL= psat+((R*(273.15+T)/(m*0.0010502))*log(pv/psat))
12 D= (4*s/(PL-pv))*(75.64-13.91*(T/100)-3*(T/100)^2)
    *10^3
13 //RESULTS
14 printf (' equilibrium pressure= %.f kPa',PL-13)
15 printf (' \n diameter of droplet= %.4f mm',D)
```

Chapter 17

Ideal solutions

Scilab code Exa 17.1 chapter 17 example 1

```
1  clc
2  //initialisation of variables
3  Pa= 40 //kPa
4  Pb= 50 //kPa
5  na= 2 //moles
6  nb= 6 //moles
7  //CALCULATIONS
8  a= Pb/Pa
9  xa= na/(na+nb)
10 xb= 1-xa
11 p= xa*Pa+xb*Pb
12 y= xa*Pa/p
13 ya= 1-y
14 Xa= a*xa/(1+(a-1)*xa)
15 Xb= 1-Xa
16 //RESULTS
17 printf (' Total pressure= %.1f kPa',p)
18 printf (' \n composition of vapour phase= %.4f ',y)
19 printf (' \n composition of vapour phase= %.4f ',ya)
20 printf (' \n composition of last drop of liquid= %.4
    f ',Xa)
```

```
21 printf (' \n composition of last drop of liquid= %.4
    f ',Xb)
```

Scilab code Exa 17.2 chapter 17 example 2

```
1 clc
2 //initialisation of variables
3 T= 290 //K
4 xa= 0.4
5 xb= 0.6
6 P= 600 //kPa
7 V= 60 //L
8 R= 8.314 //J/mol K
9 Mp= 44 //kg/kmol
10 Mb= 58.12 //kg/kmol
11 vp= 0.00171 //m^3/kg
12 vb= 0.00166 //m^3/kg
13 na= 0.1 //kmol
14 nb= 0.15 //kmol
15 V1= 0.04000 //m^3
16 xa= 0.4
17 np= 2
18 Vc= 0.1 //m^3
19 //CALCULATIONS
20 Pasat= %e^(14.435-(2255/T))
21 Pbsat= %e^(14.795-(2770/T))
22 P1= xa*Pasat+xb*Pbsat
23 Na1= P*V/(100*R*T)
24 Vp= vp*Mp
25 Vb= vb*Mb
26 V= na*Vp+nb*Vb
27 Vv= V1-V
28 nv= P1*Vv/(R*T)
29 ya= xa*Pasat/P
30 yb=1-ya
```

```

31 Na= na+ya*nv
32 Nb= nb+yb*nv
33 //RESULTS
34 printf (' initial pressure= %.2f kPa',P1)
35 printf (' \n moles of propane= %.5f kmol',Na1)
36 printf (' \n initial mole of propane= %.5f kmol',Na)
37 printf (' \n initial mole of butane= %.5f kmol',Nb)
38 printf (' \n number of phases= %.f ',np)
39 printf (' \n volume in final state= %.1f m^3',Vc)

```

Scilab code Exa 17.3 chapter 17 example 3

```

1 clc
2 //initialisation of variables
3 p0= 10 //Mpa
4 R= 8.314 //J/mol K
5 T= 30 //C
6 va= 0.02 //m^3/kmol
7 xa= 0.98
8 //CALCULATIONS
9 p= p0+(R*(273.15+T)*log(xa)/(va*1000))
10 //RESULTS
11 printf (' Pressure of the phase of pure A= %.2f Mpa',
,p)

```

Scilab code Exa 17.4 chapter 17 example 4

```

1 clc
2 //initialisation of variables
3 hfg= 2257.0 //kJ/kg
4 Tb= 100 //C
5 R= 8.314 //J/mol K
6 m2= 10 //gms

```



```

7 M2= 58.5 //gms
8 m1= 90 //gms
9 M1= 18 //gms
10 //CALCULATIONS
11 x2= (m2/M2)/((m2/M2)+(m1/M1))
12 dT= R*(273.15+Tb)^2*x2/(M1*hfg)
13 //RESULTS
14 printf (' Boiling point elevation= %.3f C',dT)

```

Scilab code Exa 17.5 chapter 17 example 5

```

1 clc
2 //initialisation of variables
3 M1= 18.02 //gms
4 m1= 0.965 //gms
5 m2= 0.035 //gms
6 M2= 58.5 //gms
7 R= 8.314 //J/mol K
8 M= 18.02 //kg
9 T= 20 //C
10 vf= 0.001002 //m^3
11 x21= 0.021856 //m^3
12 //CALCULATIONS
13 n1= m1/M1
14 n2= m2/M2
15 x1= n1/(n1+n2)
16 x2= n2/(n2+n1)
17 P= R*(273.15+T)*x2/(M*vf)
18 P1= R*(273.15+T)*x21/(M*vf)
19 //RESULTS
20 printf (' Osmotic pressure= %.1f kpa',P)
21 printf (' \n Osmotic pressure= %.1f kpa',P1)

```

Scilab code Exa 17.6 chapter 17 example 6

```
1  clc
2  //initialisation of variables
3  W= 0
4  Q= 0
5  R= 8.314 //J/mol K
6  T0= 300 //K
7  x= 5/13
8  n1= 0.5 //kmol/s
9  n2= 0.8 //kmol/s
10 //CALCULATIONS
11 W1= (n1+n2)*R*T0*(x*log(1/x)+(1-x)*log(1/(1-x)))
12 I= W1
13 //RESULTS
14 printf (' useful work of the process= %.f kW',W)
15 printf (' \n heat interaction= %.f kW',Q)
16 printf (' \n maximum work= %.1f kW',W1)
17 printf (' \n irreversibility= %.1f kW',I)
```

Chapter 18

Nonideal Solutions

Scilab code Exa 18.2 chapter 18 example 2

```
1 clc
2 //initialisation of variables
3 T= 80 //C
4 p= 30 //percent
5 pw= 47.39 //kPa
6 psat= 36 //kPa
7 //RESULTS
8 printf (' Saturation pressure= %.1f kPa',psat)
```

Scilab code Exa 18.3 chapter18 example 3

```
1 clc
2 //initialisation of variables
3 T= 120 //C
4 p= 30 //percent
5 T2= 80 //C
6 psat= 36 //kPa
7 Tw= 73 //C
```

```
8 //RESULTS
9 printf ( ' Temperature of pure water= %.1f C',Tw)
10 printf ( ' \n Saturation pressure= %.1f kPa',psat)
```

Scilab code Exa 18.5 chapter18 example 5

```
1 clc
2 //initialisation of variables
3 p= 10 //bar
4 P= 40 //percent
5 x= 0.4
6 H1= 16 //kcal/kg
7 H2= 31 //kcal/kg
8 H3= 64 //kcal/kg
9 H4= 140 //kcal/kg
10 T= 157 //C
11 He= 580 //kcal/kg
12 //RESULTS
13 printf ( ' Enthalpy= %.f kcal/kg',H1)
14 printf ( ' \n Enthalpy= %.f kcal/kg',H2)
15 printf ( ' \n Enthalpy= %.f kcal/kg',H3)
16 printf ( ' \n Enthalpy= %.f kcal/kg',H4)
17 printf ( ' \n Maximum temperature= %.f C',T)
18 printf ( ' \n Enthalpy = %.f kcal/kg',He)
```

Scilab code Exa 18.6 chapter18 example 6

```
1 clc
2 //initialisation of variables
3 v= 0.0011 //m^3
4 P1= 1200 //Mpa
5 P2= 140 //Mpa
6 h5= -103 //kJ/kg
```

```

7 x4= 0.860
8 x7= 0.253
9 x5= 0.337
10 h1= 1658.1 //kJ/kg
11 h7= 343.7 //kJ/kg
12 h6= -1008 //kJ/kg
13 h4= 639 //kJ/kg
14 h3= 40 //kJ/kg
15 Tc= -10 //C
16 Th= 125 //C
17 Ta= 25 //C
18 m1= 1 //kg/s
19 m7= 6.23 //kg/s
20 m6= 7.23 //kg/s
21 //CALCULATIONS
22 h6= h5+v*(P1-P2)
23 cr= (x4-x7)/(x5-x7)
24 Qhbym= h1+(m7/m1)*h7-(m6/m1)*h6
25 Qcbym= h4-h3
26 COP= Qcbym/Qhbym
27 COPcarnot= ((273.15+Tc)/(273.15+Th))*((Th-Ta)/(Ta-Tc
))
28 //RESULTS
29 printf ( ' Enthalpy= %.1f kJ/kg ',h6)
30 printf ( ' \n circulation ratio= %.3f ',cr)
31 printf ( ' \n COP= %.3f ',COP)
32 printf ( ' \n COP carnot= %.3f ',COPcarnot)

```

Chapter 19

Chemical Reactions

Scilab code Exa 19.1 chapter 19 example 1

```
1 clc
2 //initialisation of variables
3 pN2= 79 //percent
4 VN2= 82.3 //m^3
5 VC02= 8 //m^3
6 VC0= 0.9 //m^3
7 M= 32 //gms
8 M1= 28 //gms
9 //CALCULATIONS
10 P= (pN2/(100-pN2))
11 z= VN2/P
12 x= VC02+VC0
13 w= VC02+(VC0/2)+(VC02/10)
14 y= 2*w
15 r= y/x
16 T0= x+(y/4)
17 X= (z/T0)-1
18 AF= z*(M+P*M1)/(12*x+y)
19 //RESULTS
20 printf (' fuel ratio= %.3f ',r)
21 printf (' \n excess air= %.3f ',X)
```

```
22 printf ( ' \n emass air-fuel ratio= %.2f ',AF)
```

Scilab code Exa 19.2 chapter 19 example 2

```
1 clc
2 //initialisation of variables
3 m1= 24 //kg
4 M1= 32 //kg
5 m2= 28 //kg
6 M2= 28 //kg
7 e= 0.5
8 T3= 1800 //C
9 T0= 25 //C
10 T1= 25 //C
11 T2= 100 //C
12 R= 8.314 //Jmol K
13 cp= 4.57 //J/mol K
14 cp1= 3.5 //J/mol K
15 cp2= 3.5 //J/mol K
16 hC02= -393522 //J
17 hC0= -110529 //J
18 //CALCULATIONS
19 n1= m1/M1
20 n2= m2/M2
21 N= n1-0.5*e
22 N1= n2-e
23 N2= e
24 N3= N+N1+N2
25 y1= N/N3
26 Q= ((N*cp+N1*cp1+N2*cp2)*R*(T3-T0)-(n1*cp*(T1-T0)+n2
      *cp2*(T2-T1))+N*(hC02-hC0))/60
27 //RESULTS
28 printf ( ' Heat interaction= %.f kW ',Q)
```

Scilab code Exa 19.3 chapter 19 example 3

```
1 clc
2 //initialisation of variables
3 hC02= -393520 //kJ/kg mol
4 hH20= -285840 //kJ/kg mol
5 hC7H16= -187820 //kJ/kg mol
6 M= 100
7 hH201= -241830 //kJ/kg mol
8 //CALCULATIONS
9 HHV= -(7*hC02+8*hH20-hC7H16)/M
10 LLV= -(7*hC02+8*hH201-hC7H16)/M
11 //RESULTS
12 printf (' Higher heating vlue= %.f kJ/kg mol ',HHV)
13 printf (' \n Lower heating vlue= %.f kJ/kg mol ',LLV
    )
```

Scilab code Exa 19.4 chapter 19 example 4

```
1 clc
2 //initialisation of variables
3 T0= 25 //C
4 T1= 220 //C
5 hC02= -393520 //kJ/kg
6 hH20= -241830 //kJ/kg
7 hC3H8= -103850 //kJ/kg= 1.4
8 R= 8.314 //Jmol K
9 k= 1.4
10 k1= 1.29
11 //CALCULATIONS
12 T= T0+((15*(R*(k/(k-1))))*4.762*(T1-T0)-(3*hC02+4*
    hH20-hC3H8))/(R*((3+4)*(k1/(k1-1)))+(10+56.43)*(k
```



```

        /(k-1))))))
13 //RESULTS
14 printf ( ' adiabatic flame temperature= %.f C ',T)

```

Scilab code Exa 19.6 chapter 19 example 6

```

1 clc
2 //initialisation of variables
3 T= 25 //C
4 hfT= -241820 //kJ/kmol
5 R= 8.314 //J/mol K
6 k= 1.4
7 cpH2O= 4.45
8 cpO2= 3.5
9 T1= 1000 //C
10 //CALCULATIONS
11 S= (cpH2O-k*cpO2)
12 hfT1= hfT+S*(T1-T)
13 //RESULTS
14 printf ( ' enthalpy formation= %.f kJ/kmol ',hfT1)

```

Scilab code Exa 19.7 chapter 19 example 7

```

1 clc
2 //initialisation of variables
3 R= 8.314 //J/mol K
4 T= 25 //C
5 gf= 16590 //kJ/kmol
6 T1= 500 //C
7 Cp= 4.157 //J/mol K
8 hf= -46190 //kJ/kmol
9 //CALCULATIONS
10 K= %e^(gf/(R*(273.15+T)))

```

```

11 r= (1-((273.15+T)/(273.15+T1)))*((hf/(R*(273.15+T)))
      +(R/Cp))-2*log((273.15+T1)/(273.15+T))+0.6
12 KT1= K*%e^r
13 //RESULTS
14 printf (' equilibrium constant= %.1f bar^-1 ',K)
15 printf (' \n equilibrium constant= %.5f bar^-1 ',KT1
      )

```

Scilab code Exa 19.8 chapter 19 example 8

```

1  clc
2  //initialisation of variables
3  uC02= -394374 //J/mol
4  uC0= -137150 //J/mol
5  uO2= 0
6  R= 8.314 //J/mol K
7  T= 25 //C
8  cpC02= 4.57 //J/mol K
9  cpC0= 3.5 //J/mol K
10 cpO2= 3.5 //J/mol K
11 T1= 1500 //C
12 hf= -393522 //kJ/kmol
13 gf= -110529 //kJ/kmol
14 T2= 2500 //C
15 //CALCULATIONS
16 r= -(uC02-uC0-0.5*uO2)/(R*(273.15+T))
17 s= (cpC02-cpC0-0.5*cpO2)
18 r1= (1-((273.15+T)/(273.15+T1)))*((hf-gf)/(R
      *(273.15+T))-s)+s*log((273.15+T1)/(273.15+T))
19 KT1= %e^(r+r1)
20 r2= (1-((273.15+T)/(273.15+T2)))*((hf-gf)/(R
      *(273.15+T))-s)+s*log((273.15+T2)/(273.15+T))
21 KT2= %e^(r+r2)
22 //RESULTS
23 printf (' equilibrium constant at T1= %.3f C ',KT1)

```

```
24 printf ( ' \n equilibrium constant at T2= %.3f C ',  
          KT2)
```

Scilab code Exa 19.9 chapter 19 example 9

```
1 clc  
2 //initialisation of variables  
3 Wc= 12 //kg  
4 hf= -393520 //kJ/kmol  
5 gf= -394360 //kJ/kmol  
6 //CALCULATIONS  
7 Wmax= -gf/Wc  
8 //RESULTS  
9 printf ( ' maximum work= %.f kJ/kg of carbon ',Wmax)
```

Scilab code Exa 19.10 chapter 19 example 10

```
1 clc  
2 //initialisation of variables  
3 T= 25 //C  
4 R= 8.314 //Jmol K  
5 k= 1.27  
6 k1= 1.34  
7 hf= -393520 //kJ/kmol  
8 M= 28 //gms  
9 gf= -394360 //kJ/kmol  
10 M= 12 //gms  
11 //CALCULATIONS  
12 T1= T+(-hf/((R)*((k/(k-1))+(0.2+4.5144)*(k1/(k1-1))))  
        ))  
13 Bin= 0  
14 dh= (k1*R/(k1-1))*(T1-T)  
15 dh1= (k1*R/(k1-1))*log((273.15+T1)/(273.15+T))
```

```

16 H= dh-(273.15+T)*dh1
17 h= (k*R/(k-1))*(T1-T)+hf
18 h1= (k*R/(k-1))*log((273.15+T1)/(273.15+T))+((hf-gf)
    /(273.15+T))
19 h2= h-(273.15+T)*h1
20 Bout= (h2+(0.2+4.5144)*H)/M
21 //RESULTS
22 printf ( ' outlet temperature= %.2f C ',T1)
23 printf ( ' \n energy of formation= %.f J ',Bin)
24 printf ( ' \n energy at outlet= %.f kJ/kmol ',H)
25 printf ( ' \n energy of the products= %.f k ',Bout)

```

Scilab code Exa 19.11 chapter 19 example 11

```

1 clc
2 //initialisation of variables
3 b= 1475.30 //kJ/kg
4 b0= 144.44 //kJ/kg
5 h2= 3448.6 //kJkg
6 h1= 860.5 //kJ/kg
7 k= 1.27
8 k1= 1.34
9 R= 8.314 //J/mol K
10 hf= -393520 //kJ/kmol
11 hg= 72596 //kJ/kmol
12 Mc= 12 //kg
13 n= 1.2 //moles
14 n1= 3.76 //moles
15 M= 32 //gms
16 M1= 28 //gms
17 M2= 44 //gms
18 n2= 0.2 //moles
19 n3= 4.512 //moles
20 B1= 25592 //kJ/kmol C
21 B2= 394360 //kJ/kmol C

```

```

22 e= 0.008065
23 //CALCULATIONS
24 B= b-b0
25 Q= h2-h1
26 CpCO2= k*R/(k-1)
27 CpO2= k1*R/(k1-1)
28 Qcoal= (hg+hf)/Mc
29 mcoal= Q/(-Qcoal)
30 ncoal= mcoal/Mc
31 r= (n*M+n1*M1)/Mc
32 r1= (M2+n2*M+n3*M1)/Mc
33 mair= r*mcoal
34 mgas= r1*mcoal
35 Bfuel= (B1-B2)*e
36 Bnet= Bfuel+B
37 p= B*100/(-Bfuel)
38 //RESULTS
39 printf ( ' change in energy= %.2f kJ/kg ',B)
40 printf ( ' \n amount of air= %.3f kg/kg ',mair)
41 printf ( ' \n amount of gas= %.3f kg/kg ',mgas)
42 printf ( ' \n net change in energy= %.2f kg/kg steam
    ',Bnet)
43 printf ( ' \n percent energy in original fuel= %.2f
    percent ',p)

```
