

Scilab Textbook Companion for
Thermal Engineering
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Book Description

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Scilab numbering policy used in this document and the relation to the above book.

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

AP Appendix to Example(Scilab Code that is an Appednix to a particular Example of the above book)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means a scilab code whose theory is explained in Section 2.3 of the book.

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Chapter 1

Thermal Engineering

Scilab code Exa 1.1 example 1

```
1
2 clc
3 //initialisation of variables
4 clear
5 t1=300 //K
6 t3=1900 //K
7 r=15
8 g=1.4
9 p1=1 //bar
10 cp=1.005
11 cv=0.718
12 R=0.287 //kj/kgk
13 //CALCULATIONS
14 t2=t1*r^(g-1)
15 p2=p1*r^(g)
16 p3=p2
17 t4=t3*0.143^(g-1)
18 p4=p3*(0.143)^(g)
19 qs=cp*(t3-t2)
20 qr1=cv*(t4-t1)
21 wo=qs-qr1
```



```
22 ef=wo/qs
23 v1=R*t1/p1
24 v2=v1/r
25 sv=v1-v2
26 c1=v2/(v1-v2)
27 mep=wo/sv
28 printf('mean effective pressure is %2f',mep)
```

Scilab code Exa 1.2 example 2

```
1 clc
2 //initialisation of variables
3 t1=279 //k
4 ta=294 //k
5 th=393 //k
6 re=0.14
7 //CALCULATIONS
8 cop=(t1*(th-ta))/((ta-t1)*th)
9 acop=cop*re
10 //RESULTS
11 printf('actual COP is %2f',acop)
```

Scilab code Exa 1.3 example 3

```
1 clc
2 //initailisation variables
3 d=20 //cm
4 l=25 //cm
5 cv=1400 //cc
6 g=1.4
7 //CALCULATIONS
8 sv=(22/7*d^2*l)/4
9 tv=sv+cv
```

```
10 r=tv/cv
11 e=1-1/(r)^(g-1)
12 printf('otto efficiency is %2f',e)
```

Scilab code Exa 1.4 example 4

```
1
2 clc
3 //initialisation of variables
4 t1=305 //K
5 t3=1920 //K
6 r=7
7 g=1.4
8 p1=1 //bar
9 cv=0.718
10 R=0.287 //kj/kgk
11 //CALCULATIONS
12 t2=t1*r^(g-1)
13 p2=p1*r^(g)
14 p3=p2*(t3/t2)
15 t4=t3*1/r^(g-1)
16 p4=p3*(1/r)^(g)
17 qs=cv*(t3-t2)
18 qr1=cv*(t4-t1)
19 wo=qs-qr1
20 ef=wo/qs
21 v1=R*t1/p1
22 v2=v1/r
23 sv=v1-v2
24 cl=v2/(v1-v2)
25 mep=wo/sv
26 printf('mean effective pressure is %2f',mep)
```

Scilab code Exa 1.5 example 5

```
1 clc
2 //initialisation of variables
3 r=14
4 g=1.4
5 x=1.78 //x=v3/v2
6 //CALCULATIONS
7 oef=1-(1/14)^(g-1)
8 def=1-((1/(14)^(g)*1.4))*((x^(g)-1)/(x-1))
9 printf('otto efficiency is %2f',oef)
```

Scilab code Exa 1.6 example 6

```
1 clc
2 //initialisation of variables
3 t1=300 //temperature in k
4 r=10 //compression ratio
5 p1=1 //pressure in bar
6 g=1.4
7 p3=40 //pressure in bar
8 x=0.166 //x=v4/v5=t4/v1=(v4/v2)*(v2/v1)
9 t4=2000 //temperature in k
10 p4=40 //pressure in bar
11 cv=0.718 //calorific value(const volume)
12 cp=1.005 //calorific value(const pressure)
13 R=0.287
14 r=10
15 //CALCULATIONS
16 t2=(t1*(r)^(g-1))
17 p2=(p1*(r)^(g))
18 t3=t2*(p3/p2)
19 t5=t4*(x)^(g-1)
20 p5=p4*(x)^(g)
21 q23=cv*(t3-t2)
```

```

22 q34=cp*(t4-t3)
23 q44=cv*(t5-t1)
24 nwd=q23+q34-q44
25 ef=nwd/(q23+q34)
26 v1=(R*t1)/(p1*100)
27 v2=v1/r
28 mep=nwd/(v1-v2)
29 effo=1-(1/(r)^(g-1))
30 v3=(R*t4)/(p2*100)
31 cr=v3/v2
32 effd=1-(((1/(r)^(g-1))*(1/g)*((cr)^(g)-1)/(cr-1))
33 //RESULTS
34 printf('temparature 2,3,5 and pressure 2,5 are %2fk,
        %2fk,%2fk and %2fbar,%2fbar ',t2,t3,t5,p2,p5)
35 printf('\nheat supplied at const volume is %2fkj/kg/
        cycle ',q23)
36 printf('\nheat supplied at const pressure is %2fkj/
        kg/cycle ',q34)
37 printf('\nnet work output is %2f',nwd)
38 printf('\nefficiency is %2f',ef)
39 printf('\notto efficiency is %2f',effo)
40 printf('\ndiesel efficiency is %2f',effd)

```

Scilab code Exa 1.7 example 7

```

1 clc
2 //initialisation of variables
3 t1=295 //temparature in k
4 r=5.25
5 g=1.4
6 t3=923 //temparature in k
7 tc=511 //temparature in k
8 tt=633 //temparature in k
9 //CALCULATIONS
10 t2=t1*(r)^((g-1)/g)

```

```

11 t4=t3/(r)^((g-1)/g)
12 effb=1-((t4-t1)/(t3-t2))
13 wt=t3-t4
14 wc=t2-t1
15 wr1=(1-(t2-t1)/(t3-t4))
16 ctwr1=(t2-t1)/(t3-t4)
17 effc=(t2-t1)/(tc-t1)
18 efft=(t3-tt)/(t3-t4)
19 effbr=1-((tt-t1)/(t3-tc))
20 wr2=1-((tc-t1)/(t3-tt))
21 ctwr2=(tc-t1)/(t3-tt)
22 //RESULTS
23 printf('work ratio and compressed turbine wrok ratio
      in first part of problem are %2f and %2f',wr1,
      ctwr1)
24 printf('\nwork ratio and compressed turbine wrok
      ratio in second part of problem are %2f and %2f',
      wr2,ctwr2)

```

Chapter 4

Thermal Engineering

Scilab code Exa 4.1 example 1

```
1  clc
2  //initialisation of variables
3  t1=523.3 //temparature under p1=40 bar in k
4  t2=314.5 //temparature under p2=0.80 bar in k
5  s4=2.797 //entropy under p1=40 bar
6  s1=6.070 //entropy under p1=40 bar
7  sf3=0.593 //entropy under p2=0.08 bar
8  sfg3=7.634 //entropy under p2=0.08 bar
9  h4=1087 //kj/kg
10 h1=2801 //kj/kg
11 hf3=174 //kj/kg under p2=0.08bar
12 hfg3=2402 //kj/kg under p2=0.08bar
13 //CALCULATIONS
14 eff=(t1-t2)/t1
15 x3=(s4-sf3)/sfg3
16 x2=(s1-sf3)/sfg3
17 h3=hf3+(x3*hfg3)
18 h2=hf3+(x2*hfg3)
19 wt=h1-h2
20 cw=h4-h3
21 wr=(wt-cw)/wt
```

```

22 //RESULTS
23 printf('efficiency of carnot cycle is %2f',eff)
24 printf('\nquality is %2f',x3)
25 printf('\ngross work of expansion is %2f',wt)
26 printf('\nwork ratio is %2f',wr)

```

Scilab code Exa 4.2 example 2

```

1  clc
2  //initialisation of variables
3  v=0.1008*10^-2
4  p1=40 //pressure in bar
5  p2=0.08 //pressure in bar
6  wt=903.8 //kj/kg
7  wp=4.02 //kj/kg
8  h1=2801 //kj/kg
9  h3=174 //kj/kg
10 //CALCULATIONS
11 pw=v*(p1-p2)
12 wn=wt-wp
13 qs=h1-(h3+wp)
14 reff=wn/qs
15 wr=wn/wt
16 //RESULTS
17 printf('heat supplied is %2f',qs)
18 printf('\nrankine efficiency and work ratio is %2f
    and %2f',reff,wr)

```

Scilab code Exa 4.3.a example 3a

```

1  clc
2  //initialisation of variables
3  h1=2801 //kj/kg

```

```

4 h3=867.5 //kj/kg
5 h4=1087 //kj/kg
6 ieff=0.50 //isentropic efficiency of compression
7 wt=903.8 //kj/kg
8 feff=0.75 //furnace efficiency
9 ieeff=0.85//isentropic expansion efficiency
10 //CALCULATIONS
11 hx=((h4-h3)/0.5)+867.5
12 wr=hx-h3
13 atu=ieeff*wt
14 hs=h1-hx
15 nwo=atu-wr
16 eff=nwo/hs
17 oeff=eff*feff
18 wrt=nwo/atu
19 ssc=3600/nwo
20 hr=3600/oeff
21 //RESULTS
22 printf('steam and heat rates are %2fkj/kwh and %2fkj
/kwh', ssc, hr)

```

Scilab code Exa 4.3.b example 3 b

```

1 clc
2 //initialisation of variables
3 h3=174 //kj/kg
4 h4=178.02 //kj/kg
5 ieff=0.50 //isentropic efficiency of compression
6 wt=903.8 //kj/kg
7 feff=0.75 //furnace efficiency
8 ieeff=0.85//isentropic expansion efficiency
9 wp=4.02 //kj/kg
10 h1=2801 //kj/kg
11 //CALCULATIONS
12 hx=((h4-h3)/0.5)+174

```



```

13 wr=wp/ieff
14 atu=ieeff*wt
15 hs=h1-hx
16 nwo=atu-wr
17 eff=nwo/hs
18 oeff=eff*feff
19 wrt=nwo/atu
20 ssc=3600/nwo
21 hr=3600/oeff
22 //RESULTS
23 printf('steam and heat rates are %2fkj/kwh and %2fkj
    /kwh', ssc, hr)

```

Scilab code Exa 4.4 example 4

```

1  clc
2  //initialisation of variables
3  h1=3221.6 //kj/kg
4  s1=7.399 //kj/kgk
5  sf2=0.521 //kj/kgk
6  sfg2=7.808 //kj/kgk
7  hf2=152 //kj/kg
8  hfg2=2415 //kj/kg
9  t1=653 //temp in k
10 t2=309.2 //temp in k
11 v=0.1006*10^-2
12 p1=10 //pressure in bar
13 p2=0.06 //pressure in bar
14 h3=152 //kj/kg
15 x=110
16 y=639.7
17 z=610
18 a=2015
19 //CALCULATIONS
20 x2=(s1-sf2)/sfg2

```

```

21 h2=hf2+(x2*hf2)
22 wo=h1-h2
23 hs=h1-h3
24 theff=wo/hs
25 sr1=3600/wo
26 ceff=(t1-t2)/t1
27 wp=v*(p1-p2)
28 h4=h3+wp
29 reff=(x+y)/(z+a)
30 sr2=3600/(x+y)
31 hr=3600/reff
32 printf('steam rate and carnot efficiency are %2fkg/
      kwh and %2f',sr1,ceff)
33 printf('\nsteam rate and heat rate are %2fkg/kwh and
      %2f',sr2,hr)

```

Scilab code Exa 4.5 example 5

```

1  clc
2  //initialisation of variables
3  h1=3157 //kj/kg
4  h2=2725 //kj/kg
5  h3=3299 //kj/kg
6  h4=2257.9 //kj/kg
7  h5=1940.3 //kj/kg
8  h6=152 //kj/kg
9  x4=0.872
10 x5=0.7405
11 v=0.1006*10^-2 //volume
12 p1=100 //pressure in bar
13 p2=0.06 //pressure in bar
14 //CALCULATIONS
15 wp=v*(p1-p2)*100
16 h7=h6+wp
17 wt1=h1-h5

```

```

18 wn1=wt1-wp
19 qs1=h1-h7
20 wr1=wn1/wt1
21 reff=wn1/qs1
22 //reheat cycle
23 wt2=(h1-h2)+(h3-h4)
24 wn2=wt2-wp
25 wr2=wn2/wt2
26 qs2=h1-h7+h3-h2
27 teff=wn2/qs2
28 pd=wn2/3600
29 pdi=(pd-0.3352)/0.3352
30 df=1-pdi
31 //RESULTS
32 printf('work ratio and rakin efficiency of rankine
        cycle is %2f and %2f',wr1,reff)
33 disp('dryness fraction of steam is 0.872')
34 printf('\nheat supplied is %2f',qs1)
35 printf('\npower developed is %2f',pd)
36 printf('\npower developed per kg of steam is %2f',
        pdi)

```

Scilab code Exa 4.6 example 6

```

1 clc
2 //initialisation of variables
3 h1=2979 //kj/kg
4 h2=2504.3 //kj/kg
5 h3=1987.4 //kj/kg
6 h4=152 //kj/kg
7 h6=561 //kj/kg
8 //CALCULATIONS
9 m=(h6-h4)/(h2-h4)
10 wo=(h1-h2)+(1-m)*(h2-h3)
11 qs=h1-h6

```

```

12 teff=wo/qs
13 ssc=3600/wo
14 //RESULTS
15 printf('work output is %2fkj/kg',wo)
16 printf('\nheat supplied is %2fkj/kg',qs)
17 printf('\nthermal efficiency is %2f',teff)
18 printf('\nspecific steam consumption is %2fkg/kwh',
      ssc)

```

Scilab code Exa 4.7.a example 7a

```

1  clc
2  //initialisation of variables
3  h1=3222.5 //kj/kg
4  h2=3127.5 //kj/kg
5  h3=2692.5 //kj/kg
6  h4=2406.7 //kj/kg
7  h5=360 //kj/kg
8  h6=360 //kj/kg
9  h7=584 //kj/kg
10 h8=962 //kj/kg
11 //CALCULATIONS
12 m1=(h8-h7)/(h2-h7)
13 m2=((1-m1)*(h7-h5))/(h3-h5)
14 wo=(h1-h2)+(1-m1)*(h2-h3)+(1-m1-m2)*(h3-h4)
15 qs=h1-h8
16 teff=wo/qs
17 sr=3600/wo
18 //RESULTS
19 printf('work output is %2fkj/kg',wo)
20 printf('\nheat supplied is %2fkj/kg',qs)
21 printf('\nthermal efficiency is %2f',teff)
22 printf('\nsteam rate is %2fkg/kwh',sr)

```

Scilab code Exa 4.7.b example 7b

```
1  clc
2  //initialisation of variables
3  h1=3222.5 //kj/kg
4  h2=3127.5 //kj/kg
5  h3=2692.5 //kj/kg
6  h4=2406.7 //kj/kg
7  h5=360 //kj/kg
8  h6=360 //kj/kg
9  h7=584 //kj/kg
10 h8=962 //kj/kg
11 //CALCULATIONS
12 m1=(h8-h7)/(h2-h8)
13 m2=((h7-h6)-m1*(h8-h7))/(h3-h7)
14 wo=(h1-h2)+(1-m1)*(h2-h3)+(1-m1-m2)*(h3-h4)
15 qs=h1-h8
16 teff=wo/qs
17 sr=3600/wo
18 //RESULTS
19 printf('work output is %2fkj/kg',wo)
20 printf('\nheat supplied is %2fkj/kg',qs)
21 printf('\nthermal efficiency is %2f',teff)
22 printf('\nsteam rate is %2fkg/kwh',sr)
```

Scilab code Exa 4.8 example 8

```
1  clc
2  //initialisation of variables
3  h1=2990 //kj/kg
4  h2=2710 //kj/kg
5  h3=2325 //kj/kg
```

```

6 h4=152 //kj/kg
7 h5=152 //kj/kg
8 h7=505 //kj/kg
9 wo=612 //kj/kg
10 qs=2485 //kj/kg
11 //CALCULATIONS
12 m=(h7-h4)/(h2-h4)
13 mph=m*30000
14 ip=((h1-h2)+(1-m)*(h2-h3))*(30000/3600)
15 teff=wo/qs
16 //when there is no feeding
17 eff=(h1-h3)/(h1-h4)
18 sc=(3600/(h1-h3))*ip
19 //RESULTS
20 printf('internal powers is %2fkw',ip)
21 printf('\nthermal efficiency when feeding is there
    is %2f',teff)
22 printf('\nwhen there is no feeding ,thermal
    efficiency is %2f',eff)
23 printf('\nsteam consumption is %2fkg/h',sc)

```

Scilab code Exa 4.10 example 10

```

1 clc
2 //no 4.9 printed in the book.... print mistake
3 //initialisation of variables
4 //for the mercury cycle
5 ha=360.025 //kj/kg
6 sa=0.50625 //kj/kgk
7 sfb=0.0961 //kj/kgk
8 sfgb=0.5334 //kj/kgk
9 hfb=38.05 //kj/kg
10 hfgb=294.02 //kj/kg
11 //for the steam cycle
12 h5=2801 //kj/kg

```

```

13 h3=163 //kj/kg
14 hb=264.2 //kj/kg
15 h1=2963 //kj/kg
16 s1=6.364 //kj/kgk
17 sf2=0.559 //kj/kgk
18 sfg2=7.715 //kj/kgk
19 qs=3916.2 //kj/kg
20 hf2=163 //kj/kg
21 hfg2=2409 //kj/kg
22 //CALCULATIONS
23 xb=(sa-sfb)/sfgb
24 hb=hfb+(xb*hfgb)
25 m1=(h5-h3)/(hb-hfb)
26 x2=(s1-sf2)/sfg2
27 h2=hf2+(x2*hfg2)
28 wn=m1*(ha-hb)+(h1-h2)
29 teff1=wn/qs
30 hx=ha-(0.8*(ha-hb))
31 hy=h1-(0.8*(h1-h2))
32 m2=(h5-h3)/(hx-hfb)
33 wo=m2*(ha-hx)+(h1-hy)
34 qs=m2*(ha-hfb)+(h1-h5)
35 teff2=wo/qs
36 //RESULTS
37 printf('thermal efficiency of steam cycle is %2f',
        teff1)
38 printf('\nwork output of plant is %2fkj/kg',wo)
39 printf('\nheat supplied is %2fkj/kg',qs)
40 printf('\nthermal efficiency of the plant is %2f',
        teff2)

```

Scilab code Exa 4.11 example 11

```

1 clc
2 //initialisation of variables

```

```

3 ha=360.025 //kj/kg
4 hfb=38.05 //kj/kg
5 hb=264.2 //kj/kg
6 h1=2963 //kj/kg
7 h2=1974.6 //kj/kg
8 h3=163 //kj/kg
9 h4=1087 //kj/kg
10 h=1714 //kj/kg
11 //CALCULATIONS
12 m=h/(hb-hfb)
13 wo=7.58*(ha-hb)+(h1-h2)
14 qs=7.58*(ha-hfb)+(h4-h3)+(h1-h)
15 teff=(wo/qs)
16 //RESULTS
17 printf('thermal efficiency is %2f',teff)

```

Scilab code Exa 4.12 example 12

```

1 clc
2 //initialisation of variables
3 ha=359.11 //under 10 bar pressure in kj/kg
4 sa=0.5089 //under 10 bar pressure in kj/kgk
5 sfb=0.0870 //under 0.08 bar pressure in kj/kgk
6 sfgb=0.57 //under 0.08 bar pressure in kj/kgk
7 hfb=33.21 //under 0.08 bar pressure in kj/kg
8 hfgb=294.7 //under 0.08 bar pressure in kj/kg
9 h=1840.5 //kj/kg
10 h1=3350 //under 25 bar pressure and 723 k in kj/kg
11 s1=7.183 //under 25 bar pressure and 723 k in kj/kgk
12 sf2=0.476 //under 25 bar pressure and 723 k in kj/
   kgk
13 sfg2=7.918 //under 25 bar pressure and 723 k in kj/
   kgk
14 hf2=138 //under 25 bar pressure and 723 k in kj/kg
15 hfg2=2423 //under 25 bar pressure and 723 k in kj/kg

```



```
16 h5=964 //kj/kg
17 //CALCULATIONS
18 xb=(sa-sfb)/(sfgb)
19 hb=hfb+(xb*hfgb)
20 m=h/(hb-hfb)
21 x2=(s1-sf2)/sfg2
22 h2=hf2+(x2*hfg2)
23 wo=8.47*(ha-hb)+(h1-h2)
24 qs=8.47*(ha-hfb)+(h5-138)+(h1-2802.5)
25 teff=(wo/qs)*100
26 //RESULTS
27 printf('work output is %2f',wo) //textbook ans
    slightly varies
28 printf('\nheat supplied to the plant is %2f',qs)
29 printf('\nthermal efficiency is %2f',teff)
```

Chapter 5

Thermal Engineering

Scilab code Exa 5.1 example 1

```
1 clc
2 //initialisation of variables
3 c=300 //velocity in m/s
4 cp=1.005 //kj/kgk
5 g=1.4
6 t=478 //static temperature in k
7 p=15 //static pressure in bar
8 //CALCULATIONS
9 t0=t+((c)^2/(2*cp*1000))
10 x=(t0/t)^(g/(g-1))*p
11 //RESULTS
12 printf('stagnation temperature and stagnation
    pressure is %2fk and %2fbar ',t0,x)
```

Scilab code Exa 5.2 example 2

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

```

3 hg=2803.4 //kj/kg
4 c=300 //m/s
5 sg=6.1253 //kj/kgk
6 h2=2090.0 //kj/kg
7 //CALCULATIONS
8 h0=hg+((c)^2)/2000
9 c2=44.72*(h0-h2)^0.5
10 //RESULTS
11 printf('total enthalpy is %2fkj/kg',h0) //textbook
    answer is wrong
12 printf('\nfinal stream is %2fm/s',c2) //textbook
    answer is wrong

```

Scilab code Exa 5.3.a example 3a

```

1 clc
2 //initialisation of variables
3 R=0.2897 //kj/kgk
4 g=1.4
5 t1=313 //temparature in k
6 p1=20 //pressure in bar
7 p2=13 //pressure im bar
8 cp=1.0138 //kj/kgk
9 a=5*10^-4
10 //CALCULATIONS
11 rc=(2/(g+1))^(g/0.4)
12 t2=t1*(p2/p1)^((g-1)/g)
13 c2=44.72*(cp*(t1-t2))^(0.5)
14 rho=p2*100/(R*t2)
15 m=rho*c2*a
16 //RESULTS
17 printf('mass f;ow rate and velocity of air at exit
    are %2fkg/s and %2fkg/m*m*m',m,rho) //textbook
    answer slightly varies

```

Scilab code Exa 5.3.b example 3 b

```
1  clc
2  //initialisation of variables
3  R=0.2897 //kj/kgk
4  g=1.4
5  t1=313 //temparature in k
6  p1=20 //pressure in bar
7  p2=10.56 //pressure im bar
8  cp=1.0138 //kj/kgk
9  a=5*10^-4
10 //CALCULATIONS
11 rc=(2/(g+1))^(g/0.4)
12 t2=t1*(p2/p1)^((g-1)/g)
13 c2=44.72*(cp*(t1-t2))^(0.5)
14 rho=p2*100/(R*t2)
15 m=rho*c2*a
16 //RESULTS
17 printf('mass flow rate and velocity of air at exit
    are %2fkg/s and %2fkg/m*m*m',m,rho)
```

Scilab code Exa 5.4 example 4

```
1  clc
2  //initialisation of variables
3  x=100 //x=h1-h* in kj/kg
4  m=120 //mass in kg
5  pi=(22/7)
6  y=501.5 //y=h1-h2 in kj/kg
7  v1=0.607 //volume
8  v2=6.477 //volume
9  //CALCULATIONS
```

```

10 c1=44.72*(x)^(0.5)
11 a1=m*v1/(c1*60)
12 d1=(4*a1/pi)^0.5
13 c2=44.72*(y)^(0.5)
14 a2=m*v2/(c2*60)
15 d2=(4*a2/pi)^0.5
16 //RESULTS
17 printf('area of cross section of throat and diameter
        of throat are %2fm*m and %2fm',a1,d1)
18 printf('\narea of cross section at exit and diameter
        at exit are %2fm*m and %2fm',a2,d2)

```

Scilab code Exa 5.5 example 5

```

1
2 clc
3 //initialisation of variables
4 clear
5 t1=593 //temperature in k
6 p2=1.05 //pressure in bar
7 p1=7 //pressure in bar
8 cp=1.005
9 p3=3.696 //pressure in bar
10 r=0.287 //kj/kgk
11 a=6.25*10^-4
12 g= 32.2 //ft/sec^2
13 R= 8.314
14 //CALCULATIONS
15 t2=t1*(p2/p1)^((g-1)/g)
16 c2=44.72*(cp*(t1-t2))^(0.5)
17 rho2=p2*100/(r*t2)
18 m2=rho2*c2*a
19 t3=t1*(p3/p1)^((g-1)/g)
20 c3=44.72*(cp*(t1-t3))^(0.5)
21 rho3=p3*100/(R*t3)

```

```

22 a3=m2/(rho3*c3)
23 //RESULTS
24 printf('exit velocity and mass flow rate are %2fm/s
        and %2fkg/s ',c2,m2)
25 printf('\nthroat area is %2fm*m',a3)

```

Scilab code Exa 5.6 example 6

```

1
2 clc
3 //initialisation of variables
4 clear
5 g=1.4 //gamma-const value
6 p1=4.5 //pressure in bar
7 p3=1.1 //pressure in bar
8 cp=1.005 //kj/kgk
9 rho4=0.5405 //density
10 rho3=0.9725 //density
11 t1=1023 //temparature in k
12 t2=852.16 //temparature in k
13 r=0.287 //cp-cv=const value
14 m=0.5 //mass
15 ieff=0.85 //isentropic efficiency
16 R= 8.314
17 //CALCULATIONS
18 p2=0.528*p1
19 t2=0.833*t1
20 c2=44.72*(cp*(t1-t2))^(0.5)
21 rho2=p2*100/(R*t2)
22 a2=m/(rho3*c2)
23 t3=t2*(p3/p2)^((g-1)/g)
24 t4=t2-(ieff*(t2-t3))
25 c3=44.72*(cp*(t1-t4))^(0.5)
26 rho3=p2*100/(R*t4)
27 a3=m/(rho4*c3)

```

```

28 //RESULTS
29 printf('throat area is %2fm*m',a2)
30 printf('\nvelocity at exit,area at exit are %2fm/s
    and %2fm*m',c3,a3)

```

Scilab code Exa 5.7 example 7

```

1  clc
2  //initialisation of variables
3  p1=5 //pressure in bars
4  h1=2709 //kj/kg
5  h2=2649.5 //kj/kg
6  v2=0.6059 //volume flowrate in m*m*m/kg
7  m=2 //mass in kg
8  v3=6.5098 //volume flowrate in m*m*m/kg
9  h1=2714.0 //kj/kg
10 h2=2649.5 //kj/kg
11 h3=2247.4 //kj/kg
12 eff=0.9 //efficiency
13 //CALCULATIONS
14 p2=0.578*p1
15 c2=44.72*(h1-h2)^(0.5)
16 a2=m*v2/c2
17 x=eff*(h1-h3) //x=h1-h3
18 c3=44.72*(x)^(0.5)
19 a3=m*v3/c3
20 //RESULTS
21 printf('velocity and area at throat are %2fm/s and
    %2fm*m',c2,a2)
22 printf('\nvelocity and area at exit are %2fm/s and
    %2fm*m',c3,a3)

```

Scilab code Exa 5.8 example 8

```

1
2 clc
3 //initialisation of variables
4 clear
5 t1=323 //temp in k
6 c1=300 //velocity in m/s
7 c2=100 //velocity in m/s
8 cp=1.005 //kj/kgk
9 p1=10 //pressure in bar
10 p3=14 // pressure in bar
11 g= 32.2 //ft/sec^2
12 //CALCULATIONS
13 t2=t1+(((c1)^2)+(c2)^2)/(2*cp)
14 p2=p1*(t2/t1)^(g/(g-1))
15 t2=t1*(p3/p1)^((g-1)/g)
16 h3=cp*t2
17 x=(0.5*((c1)^2-(c2)^2))/1000 //x=h2-h1
18 h1=cp*t1
19 eff=(h3-h1)/(x)
20 //RESULTS
21 printf('diffuser efficiency is %2f',eff)

```

Scilab code Exa 5.9 example 9

```

1 clc
2 //initialisation of variables
3 t1=323 //temperature in k
4 t2=362.8 //temperature in k
5 c1=300 //velocity in m/s
6 c2=100 //velocity in m/s
7 cp=1.005 //kj/kgk
8 p1=10 //pressure in bar
9 p3=14 // pressure in bar
10 g=1.4
11 //CALCULATIONS

```



```

12 tx=t1+((c1)^2/(2*cp*1000))
13 po1=p1*(tx/t1)^(g/(g-1))
14 po2=p3*(tx/t2)^(g/(g-1))
15 tpr=po2/po1
16 rrr=(po2-p1)/(po1-p1)
17 //RESULTS
18 printf('total pressure ratio and ram recovery ratio
        are %2f and %2f',tpr,rrr)

```

Scilab code Exa 5.10 example 10

```

1  clc
2  //initialisation of variables
3  h1=2724.7 //kj/kg under 3 bar pressure
4  s1=6.991 //kj/kgk under 3 bar pressure
5  sf2=1.530 //kj/kgk
6  sfg2=5.597 //kj/kgk
7  hf2=504.7 //kj/kg
8  hfg2=2201.6 //kj/kg
9  vg2=0.8854
10 a2=3*10^-4 //area in m*m
11 v1=0.6056 //m*m*m/kg
12 p1=3 //bar
13 p2=2 //bar
14 n=1.3
15 t1=406.54 //temparature in k
16 ps=0.917 //bar
17 v2=0.8273 //m*m*m/kg
18 //CALCULATIONS
19 x2=(s1-sf2)/(sfg2)
20 h2=hf2+(x2*hfg2)
21 v2=x2*vg2
22 c2=44.72*(h1-h2)^(0.5)
23 m1=a2*c2/v2
24 v2=v1*(p1/p2)^(1/n)

```

```
25 c3=((-2*n/n-1)*p1*v1*((p2/p1)^((n-1)/n)-1))
    ^0.5*543.53
26 m2=a2*c3/v2
27 t2=t1*(p2/p1)^((n-1)/n)
28 de=2/ps
29 //RESULTS
30 printf('mass flow rate is %2f',m2)
31 printf('\ndegree of super saturation is %2f',de)
```

Chapter 6

Thermal Engineering

Scilab code Exa 6.1 example 1

```
1  clc
2  //initialisation of variables
3  c=400 //steam speed in m/s
4  alpa=12 //angle in degrees
5  cwo=0
6  pi=(22/7)
7  //CALCULATIONS
8  u=c*cos(12*(pi/180))/2
9  cwi=c*cos(12*(pi/180))
10 cfi=c*sin(12*(180/pi))
11 theta=atan(cfi/(cwi-u))*(pi/180)
12 cro=sqrt((cfi)^2+(cwi-u)^2)
13 phi=acos(u/cro)*(180/pi)
14 wo=(cwi-cwo)*u
15 ke=(c)^2/2
16 eff=wo/ke
17 //RESULTS
18 printf('blade efficiency is %2f',eff)
```

Scilab code Exa 6.2 example 2

```
1  clc
2  //initialisation of variables
3  hd=159 //heat drop in kj/kg
4  eff=0.89 //and its corresponding efficiency is
      mentioned
5  ra=0.4 //ratio of blade speed to steam speed
6  sp=3000 //rotational speed of an impulse turbine
      wheel in revolutions
7  a=20 //angle is 20 degrees
8  beff=0.76 //blade efficiency
9  cwo=5.4 //m/s
10 pi=(22/7)
11 bvc=0.82 //blade velocity coefficient
12 m=15 //mass is 15 kgs
13 //CALCULATIONS
14 ci=44.72*sqrt(eff*hd)
15 u=ci*ra
16 dm=(60*u)/(sp*0.3184)
17 cfi=ci*sin(20*(pi/180))
18 cwi=ci*cos(20*(pi/180))
19 cri=sqrt((cwi-u)^2+(cfi)^2)
20 cro=bvc*cri
21 x=(beff*(ci)^2)/(2*u) //x=cwi-cwo
22 theta=atan((cfi/(cwi-u)))*(180/pi)
23 cfo=sqrt((cro)^2-(cwo+u)^2)
24 co=sqrt((cwo)^2+(cfo)^2)
25 bet=(asin(cfo/co))*(180/pi)
26 pd=(m*x*u)/1000
27 re=hd-(pd/15)
28 phi=asin((cfo/cro))*(180/pi)
29 //RESULTS
30 printf('mean blade ring diameter is %2fm',dm) //
      textbook answer is wrong
31 printf('\npower developed is %2fkW',pd)
32 printf(' \nresidual energy at out let foe friction
      and nozzle efficiency is %2fkW/kg',re)
```

```
33 printf('\nblade angles are %2f,%2f,%2f',theta,bet,
    phi)
```

Scilab code Exa 6.3 example 3

```
1 clc
2 //initialisation of variables
3 alpha=20 //angle in degrees
4 theta=27 //angle in degrees
5 m=10 //kgs
6 vs=0.4799 //specific volume in m*m*m/kg
7 pi=(22/7)
8 u=100 //blade speed in m/s
9 //CALCULATIONS
10 ci=u*tan(27*(pi/180))/(cos(20*(pi/180))*tan(27*(pi
    /180))-sin(20*(pi/180)))
11 x=2*ci*cos(20*(pi/180))-u
12 pd=m*x*u
13 cf=ci*sin(20*(pi/180))
14 a=(m*vs)/cf
15 dm=sqrt(a/(0.08*pi))
16 h=0.08*dm
17 //RESULTS
18 printf('power developed is %2fw',pd)
19 printf('\narea of flow is %2fm*m',a)
20 printf('\nblade height is %2fm',h)
```

Scilab code Exa 6.4 example 4

```
1 clc
2 //initialisation of variables
3 sp=1500 //rotational speed of an impulse turbine
    wheel in revolutions
```

```

4 pi=(22/7)
5 dm=1.5 //diameter in m
6 ra=0.8 //ratio of blade speed to steam speed
7 x=159 //x=cwi-cwo in m/s
8 m=10 //kgs mass
9 cf=50.4 //m*m*m/kg
10 vs=1.159 //
11 //CALCULATIONS
12 u=(pi*dm*sp)/60
13 ci=u/ra
14 pd=(m*x*u)/1000
15 a=(m*vs)/cf
16 h=a/(pi*dm)
17 //RESULTS
18 printf('power developed for steam flow is %2fkw',pd)
19 printf('\nheight of the blade is %2fm',h)

```

Scilab code Exa 6.5 example 5

```

1 clc
2 //initialisation of variables
3 u=170 //blade velocity in m/s
4 ra=0.2 //ratio of blade speed to steam speed
5 cril=696 //m/s
6 co1=0.84 //velocity coefficient
7 co2=0.87 //velocity coefficient
8 co3=0.90 //velocity coefficient
9 cri2=232 //m/s
10 //CALCULATIONS
11 ci=u/ra
12 crol=cril*co1
13 ci2=crol*co2
14 cro2=cri2*co3
15 wd=(1176+344)*u*10^-3
16 beff=wd*1000*2/(ci^2)

```

```

17 //RESULTS
18 printf('work developed in the blade is %2fkj/kg',wd)
19 printf('\nblading efficiency is %2f',beff)

```

Scilab code Exa 6.6 example 6

```

1  clc
2  //initialisation of variables
3  u=250 //blade speed in m/s
4  theta=80 //angle in degrees
5  alpha=20 //angle in degrees
6  oed=786.7 //overall enthalpic drop in kj/kg
7  sp=3000 //rotational speed of an impulse turbine
      wheel in revolutions
8  p=6000 //power developed in kw
9  rf=1.04 //reheat factor
10 ie=2993.4 //kj/kg
11 vs=9.28 //m*m*m/kg
12 pi=(22/7)
13 //CALCULATIONS
14 ci=(u*sin(100*(pi/180)))/sin(60*(pi/180))
15 x=(2*ci*cos(20*(pi/180)))-u //x=cwi-cwo
16 wd=x*u*10^-3
17 ed=wd*10
18 teff=ed/oed
19 seff=teff/rf
20 m=p/ed
21 ae=ie-ed
22 cf=ci*sin(20*(pi/180))
23 a=(m*vs)/cf
24 dm=(60*u)/(pi*sp)
25 h=a/(pi*dm)
26 //RESULTS
27 printf('enthalpy drop is %2fkj/kg',ed)
28 printf('\nturbine efficiency is %2f',teff)

```

```
29 printf('\nstage efficiency is %2f',seff)
30 printf('\nmass flow of steam is %2fkg/s',m)
31 printf('\nblade height us %2fm',h)
```

Scilab code Exa 6.7 example 7

```
1  clc
2  //initialisation of variables
3  x1=3025 // according to 20 bar pressure and 300
         degrees temp
4  x2=2262 //according to 20 bar pressure and 300
         degrees temp
5  x3=2039 //according to 20 bar pressure and 300
         degrees temp
6  x4=2896 //according to 20 bar pressure and 300
         degrees temp
7  x5=2817 //according to 20 bar pressure and 300
         degrees temp
8  x6=2728 //according to 20 bar pressure and 300
         degrees temp
9  x7=2699 //according to 20 bar pressure and 300
         degrees temp
10 x8=2592 //according to 20 bar pressure and 300
         degrees temp
11 x9=2525 //according to 20 bar pressure and 300
         degrees temp
12 x10=2430 //according to 20 bar pressure and 300
         degrees temp
13 x11=2398 //according to 20 bar pressure and 300
         degrees temp
14 x12=2262 //according to 20 bar pressure and 300
         degrees temp
15 x13=2192 //according to 20 bar pressure and 300
         degrees temp
16 //CALCULATIONS
```



```
17 ieff=(x1-x2)/(x1-x3)
18 feff=(x1-x4)/(x1-x5)
19 seff=(x4-x6)/(x4-x7)
20 teff=(x6-x8)/(x6-x9)
21 oeff=(x8-x10)/(x8-x11)
22 yeff=(x10-x12)/(x10-x13)
23 ced=(x1-x5)+(x4-x7)+(x6-x9)+(x8-x11)+(x10-x13)
24 rf=ced/(x1-x3)
25 //RESULTS
26 printf('cumulative enthaloy drop is %2f',ced)
27 printf('\nreheat factor is %2f',rf)
```

Chapter 7

Thermal Engineering

Scilab code Exa 7.1 example 1

```
1 clc
2 //initialisation of variables
3 ps=0.024853 //at 21 degress
4 phi=0.34 //relative humidity
5 p=1.013 //pressure in bar
6 //CALCULATIONS
7 pv=ps*phi
8 w=0.622*(pv/(p-pv))
9 tdew=4.5 //at 0.00845 bar
10 //RESULTS
11 printf('specific humidity is %2fk/kg of da',w)
12 disp('dew point temp is 4.5 degrees ',tdew)
```

Scilab code Exa 7.2 example 2

```
1 clc
2 //initialisation of variables
3 t1=26 //temp in degrees
```

```

4 t2=32 //temp in degrees
5 pvs=0.033597 //pressure in bar
6 ps=0.047534 //pressure in bar
7 p=1.013 //pressure in bar
8 a=6.6*10^-4
9 //CALCULATIONS
10 pv=pvs-(p*a*(t2-t1))
11 w=(0.622*pv)/(p-pv)
12 phi=pv/ps
13 //RESULTS
14 printf('specific humidity is %2fk/kg of da',w)
15 printf('\nrelative humidity is %2f',phi)
16 disp('dew point temp is 23.5 degrees') //from steam
    tables

```

Scilab code Exa 7.3 example 3

```

1 clc
2 //initialisation of variables
3 ps=0.042415 //under 30 degrees temp in bar
4 vg=32.929 //m*m*m/kg
5 phi=0.3 //relative humidity
6 p=1.01325 //bar
7 pv=0.012725^10^2 //pressure
8 rv=0.4615
9 t=313 //temp in k
10 pa=1.005*10^2
11 ra=0.287
12 //CALCULATIONS
13 pv=phi*ps
14 w1=0.622*(pv/(p-pv))
15 rhos=1/vg
16 rhov=phi*rhos
17 rho=pv/(rv*t)
18 pa=p-pv

```

```

19 rhoa=pa*100/(ra*t)
20 w2=rhov/rhoa
21 ds=phi*((p-ps)/(p-pv))
22 //RESULTS
23 printf('partial pressure of water vapour is %2fbar',
        pv)
24 printf('\ndensity of dry air is %2fkg/m*m*m',rhoa)
25 disp('dew point temp is 10.5 degrees')
26 printf('\nspecific humidity is %2fkg/kg of da',w2)
        //textbook answer slightly varies
27 printf('\ndegree of saturation is %2f',ds)

```

Scilab code Exa 7.4 example 4

```

1 clc
2 //initialisation of variables
3 ps=0.035636 //pressure in bar
4 pvw=0.018168 //pressure in bar
5 p=1.01325 //pressure in bar
6 a=6.6*10^-4
7 w=0.00667
8 td=27 //temparature in degrees
9 tw=16 //temparature in degrees
10 //CALCULATIONS
11 pv=pvw-(p*a*(td-tw))
12 w=0.622*(pv/(p-pv))
13 phi=pv/ps
14 h=(1.005*td+w*(2500+1.86*td))
15 //RESULTS
16 printf('humidity ratio is %2fkg/kg of da',w)
17 printf('\nrelative humidity is %2f',phi)
18 disp('dew point temparature is 8 degrees')
19 printf('\nenthalphy of moist air is %2fkg/kg of da',
        h)

```

Scilab code Exa 7.5 example 5

```
1  clc
2  //initialisation of variables
3  p=1.01325 //pressure in bar
4  pv=0.020 //pressure in bar at 21 degrees temp
5  ws=0.0154 //kg/kg of da
6  w=0.0123 //kg/kg of da
7  vs=0.86 //under 21 degrees temp m*m*m/kg
8  w1=0.0074
9  //CALCULATIONS
10 pa=p-pv
11 sr=w/ws
12 rho=1/vs
13 avc=0.0163-w1
14 //RESULTS
15 printf('partial pressure of vapour and dry air are
        %2fbar and %2fbar',pv,pa)
16 disp('dew point temp is 17.4 degrees')
17 disp('specific humidity is 0.0123 kg/kg of da')
18 printf('\nsaturation ratio is %2f',sr)
19 printf('\ndensity of misture is %2fkg/m*m*m',rho)
20 printf('\namount of water vapour condensed is %2fkg/
        kg of da',avc)
```

Scilab code Exa 7.6 example 6

```
1  clc
2  //initialisation of variables
3  p=1.01325 //pressure in bar
4  w1=0.01468
5  td=20 //temp in degrees
```

```

6 tw=40 //temp in degrees
7 //CALCULATIONS
8 ha=(1.005*td+w1*(2500+1.86*td))
9 w2=(ha-(1.005*tw))/(2500+1.86*tw)
10 //RESULTS
11 printf('humidity rate is %2fk/kg of da',ha)
12 printf('\nw2 is %2fk/kg of da',w2)

```

Scilab code Exa 7.7 example 7

```

1 clc
2 //initialisation of variables
3 ps1=0.006566 //bar pressure
4 phi1=0.6 //relative humidity
5 td2=21 //temp in degrees
6 td1=1 //temp in degrees
7 ps2=0.02486 //pressure in bar
8 td3=26 //temp in degrees
9 p=1.013 //pressure in bar
10 //CALCULATIONS
11 pv1=(phi1*ps1)
12 w=0.622*(pv1/(p-pv1))
13 q=(td2-td1)*(1.005+(1.86*w))
14 phi2=pv1/ps2
15 cbf=(td3-td2)/(td3-td1)
16 cf=1-cbf
17 //RESULTS
18 printf('heat supplied to air is %2fk/kg of da',q)
19 printf('\nfinal relative humidity is %2fk/kg of da',
    ,phi2)
20 printf('\ncoil bypass factor is %2f',cbf)
21 printf('\ncontact factor is %2f',cf)

```

Scilab code Exa 7.8 example 8

```
1  clc
2  //initialisation of variables
3  ps1=0.056216 //bar pressure
4  phi1=0.2 //relative humidity
5  td1=35 //temp in degrees
6  p=1.01325 //pressure in bar
7  td2=25 //temp in degrees
8  ps2=0.03166 //bar
9  //CALCULATIONS
10 pv1=phi1*ps1
11 w1=0.622*(pv1/(p-pv1))
12 ha=(1.005*td1+w1*(2500+1.86*td1))
13 w2=(ha-(1.005*td2))/(2500+1.86*td2)
14 pv2=(w2*p)/(w2+0.622)
15 phi2=pv2/ps2
16 //RESULTS
17 printf('relative humidity rate is %2fk/kg of da',ha
    )
18 printf('\nrelative humidity is %2f',phi2)
19 printf('\namount of water to be added is %2fk/kg of
    da',w2)
```

Scilab code Exa 7.9 example 9

```
1  clc
2  //initialisation of variables
3  ps1=0.056216 //bar pressure
4  ps3=0.023366 //bar pressure
5  phi1=0.6 //relative humidity
6  td3=20 //temp in degress
7  td1=35 //temp in degrees
8  td2=12 //temp in degrees
9  r=0.287
```

```

10 p=1.01325 //pressure in bar
11 x1=90.12 //kj/kg
12 x2=34.08 //kj/kg
13 x3=42.25 //kj/kg
14 hf=0.4 //kj/kg
15 w1=0.02142
16 w2=0.00873
17 //CALCULATIONS
18 pv1=phi1*ps1
19 w1=0.622*(pv1/(p-pv1))
20 h1=(1.005*td1+w1*(2500+1.86*td1))
21 pv3=phi1*ps3
22 w3=0.622*(pv3/(p-pv3))
23 h3=(1.005*td3+w3*(2500+1.86*td3))
24 h2=(1.005*td2+0.0073*(2500+1.86*td2))
25 ma=((p-pv1)*100*2.5)/(r*(td1+273))
26 q1=ma*(x2-x1)+(w1-w2)*hf
27 q2=(ma*(x3-x2))
28 //RESULTS
29 printf('mass of dry air is %2fkg/s',ma)
30 printf('\ncooler load on the dehumidifier is %2fkW',
    q1)
31 printf('\nheating load of the heater is %2fkW',q2)

```

Scilab code Exa 7.10 example 10

```

1 clc
2 //initialisation of variables
3 x1=90.12 //kj/kg
4 x3=42.25 //kj/kg
5 ps3=0.023366 //bar pressure
6 td3=35 //temp in degrees
7 phi1=0.6 //relative humidity
8 p=1.01325 //pressure in bar
9 //CALCULATIONS

```



```

10 pv3=phi1*ps3
11 w3=0.622*(pv3/(p-pv3))
12 h3=(1.005*td3+w3*(2500+1.86*td3))
13 qs=h3-x3
14 ql=x1-h3
15 shf=qs/(qs+ql)
16 //RESULTS
17 printf('sensible heat removed is %2fkj/kg of da',qs)
18 printf('\nlatent heat removed is %2fkj/kg of da',ql)
19 printf('\nsensible heat factor is %2f',shf)

```

Scilab code Exa 7.11 example 11

```

1  clc
2  //initialisation of variables
3  ps1=0.010720 //bar pressure
4  phi1=0.3 //relative humidity
5  td1=8 //temp in degrees
6  td2=32 //temp in degrees
7  td3=30 //temp in degrees
8  ps3=0.042415 //bar pressure
9  phi3=0.5 //relative humidity
10 hf=762.6 //kj/kg
11 hfg=2013.6 //kj/kg
12 p=1.01325 //pressure in bar
13 //CALCULATIONS
14 pv1=phi1*ps1
15 w1=0.622*(pv1/(p-pv1))
16 h1=(1.005*td1+w1*(2500+1.86*td1))
17 h2=(1.005*td2+w1*(2500+1.86*td2))
18 ha=h2-h1
19 pv3=phi3*ps3
20 w3=0.622*(pv3/(p-pv3))
21 h3=(1.005*td3+w3*(2500+1.86*td3))
22 wa=w3-w1

```

```

23 hw=(h3-h2)/(w3-w1)
24 x=(hw-hf)/hfg
25 //RESULTS
26 printf('heat added is %2fkj/kg of da',ha)
27 printf('\nwater added is %2fkg/kg of da',wa)
28 disp('temp os steam supplied is 179.88 degrees') //
    at 10 bar pressure
29 printf('\nsteam required is %2fkj/kg of steam',hw)
30 printf('\nquality of steam at 10 bar is %2f',x)

```

Scilab code Exa 7.12 example 12

```

1  clc
2  //initialisation of variables
3  ps1=0.023366 //bar pressure
4  phi1=0.4//relative humidity
5  td1=20 //temp in degrees
6  m1=40 //kg/s
7  ps2=0.01227 //bar pressure
8  phi2=0.8//relative humidity
9  td2=10 //temp in degrees
10 m2=20 //kg/s
11 p=1.01325 //pressure in bar
12 //CALCULATIONS
13 pv1=phi1*ps1
14 w1=0.622*(pv1/(p-pv1))
15 h1=(1.005*td1+w1*(2500+1.86*td1))
16 ma1=m1/(1+w1)
17 pv2=phi2*ps2
18 w2=0.622*(pv2/(p-pv2))
19 h2=(1.005*td2+w2*(2500+1.86*td2))
20 ma2=m2/(1+w2)
21 w3=((ma1*w1)+(ma2*w2))/(ma1+ma2)
22 h3=((ma1*h1)+(ma2*h2))/(ma1+ma2)
23 td3=((ma1*td1)+(ma2*td2))/(ma1+ma2)

```

```

24 //RESULTS
25 printf('specific humidity is %2fkj/kg of da',w3)
26 printf('\ntemperature of air leaving chamber is
    %2fdegrees ',td3)

```

Scilab code Exa 7.13 example 13

```

1
2 clc
3 //initialisation of variables
4 clear
5 ps1=0.062739 //bar pressure
6 phi1=0.9 //relative humidity
7 td1=37 //temp in degrees
8 td3=10.7 //dew point temperature
9 ps4=0.02366 //bar pressure
10 phi4=0.55 //relative humidity
11 td4=20 //temp in degrees
12 w12=1.5 //work input in kw
13 v4=50 //
14 t4=310 //temp in k
15 r= 1
16 w2= 1
17 w3= 1
18 hf3= 2
19 p=1.01325 //pressure in bar
20 //CALCULATIONS
21 pv1=phi1*ps1
22 w1=0.622*(pv1/(p-pv1))
23 h1=(1.005*td1+w1*(2500+1.86*td1))
24 pv4=phi4*ps4
25 w4=0.622*(pv4/(p-pv4))
26 h4=(1.005*td4+w4*(2500+1.86*td4))
27 h3=(1.005*td3+w4*(2500+1.86*td3))
28 pa4=p-pv4

```

```

29 ma=(pa4*v4*100)/(r*t4)
30 q12=(w12*60)/ma
31 h2=h1+q12
32 q23=((h3+(w2-w3)*hf3)-h2)
33 Q23=-1*q23*ma
34 q34=h4-h3
35 Q34=q34*ma
36 //RESULTS
37 printf('enthalpy rate 1 is %2fkj/kg of da',h1)
38 printf('\nenthalpy rate 4 is %2fkj/kg of da',h4)
39 printf('\nenthalpy rate 3 is %2fkj/kg of da',h3)
40 printf('\nmass of dry air is %2fkg/min',ma)
41 printf('\nenthalpy rate 2 is %2fkj/kg of da',h2)
42 printf('\ncapacity od cooling coil q23 is %2fkj/min',
    ,Q23)
43 printf('\ncapacity od cooling coil q34 is %2fkj/min',
    ,Q34)

```

Scilab code Exa 7.14 example 14

```

1  clc
2  //initialisation of variables
3  td3=15 //dew point temperature
4  ps3=0.017039 //bar pressure
5  phi3=0.55 //relative humidity
6  p=1 //bar pressure
7  ps4=0.029821 //bar pressure
8  phi4=1 //relative humidity
9  td4=24 //temp in degrees
10 mw1=1000 //kg/min
11 hf1=109 //kj/kg
12 hf2=50.4 //kj/kg
13 w4=0.01912
14 w3=0.00588
15 //CALCULATIONS

```

```

16 pv3=phi3*ps3
17 w1=0.622*(pv3/(p-pv3))
18 h3=(1.005*td3+w3*(2500+1.86*td3))
19 pv4=phi4*ps4
20 w4=0.622*(pv4/(p-pv4))
21 h4=(1.005*td4+w4*(2500+1.86*td4))
22 ma=mw1*(hf1-hf2)/(h4-h3-(w4-w3)*hf2)
23 x=ma*(w4-w3) //mw1-mw2
24 mf=ma+x
25 pl=(x/mw1)*100
26 //RESULTS
27 printf('mass of dry air is %2f',ma)
28 printf('\nmass cooling water loss by evoporation is
    %2f',x)
29 printf('\nmass flow of moist air is %2f',mf)
30 printf('\npercentage loss by evoporation is %2f',pl)

```

Scilab code Exa 7.15 example 15

```

1 clc
2 //initialisation of variables
3 td3=17 //dew point temperature
4 ps3=0.019362 //bar pressure
5 phi3=0.6 //relative humidity
6 p=0.98 //bar pressure
7 t3=290 //temp in k
8 ps4=0.042415 //bar pressure
9 phi4=1 //relative humidity
10 td4=30 //temp in degrees
11 mw2=80
12 v=110 //volume
13 ma=127.98
14 w4=0.02814
15 w3=0.007464
16 r=0.287

```

```

17 hf1=209.3
18 //CALCULATIONS
19 pv3=phi3*ps3
20 w3=0.622*(pv3/(p-pv3))
21 h3=(1.005*td3+w3*(2500+1.86*td3))
22 pa3=p-pv3
23 m=(pa3*v*100)/(r*t3)
24 h2=h3+(240/ma)
25 pv4=phi4*ps4
26 w4=0.622*(pv4/(p-pv4))
27 h4=(1.005*td4+w4*(2500+1.86*td4))
28 mw1=mw2+ma*(w4-w3)
29 hf2=((mw1*hf1)+(ma*h2)-(ma*h4))/mw2
30 //RESULTS
31 printf('mass of dry air is %2fkj/min',m)
32 printf('\nenthalpy rate 3 is %2fkj/kg of da',h3)
33 printf('\nenthalpy rate 2 is %2fkj/kg of da',h2)
34 printf('\nenthalpy rate 4 is %2fkj/kg of da',h4)
35 printf('\nenthalpy rate is %2fkj/kg of da',hf2)
36 disp('temperature of water leaving the tower is 27.1
degrees')

```

Scilab code Exa 7.16 example 16

```

1
2 clc
3 //initialisation of variables
4 clear
5 uw=2.5
6 aw=127.82
7 to=34 //temp in degrees
8 tr=26 //temp in degrees
9 ur=1.5
10 ar=90
11 ag=8.68

```

```

12 clf1=100
13 pvwo=0.037782
14 p=1.013 //pressure in bar
15 a=6.66*10^-4
16 phi=0.5
17 //CALCULATIONS
18 shgw=uw*aw*(to-tr)
19 shgr=ur*ar*(to-tr)
20 sg=ag*clf1
21 pvo=pvwo-(p*a*(to-tr))
22 wo=0.622*(pvo/(p-pvo))
23 ho=(1.005*to+wo*(2500+1.86*to))
24 pvr=phi*pvo
25 wr1=0.622*(pvr/(p-pvr))
26 hr=(1.005*tr+wr1*(2500+1.86*tr))
27 //RESULTS
28 disp('recommended indoor conditions are 25.5–26.7
        degrees and 50% rh and outdoor conditions are 26
        degrees and 50%rh')
29 disp('area of the roof is 90 m*m')
30 disp('overall heat transfer coefficients are 2.5 w/m*
        m')
31 printf('\nsensible heat gain through walls is %2f',
        shgw)
32 printf('\nsensible heat gain through roofs is %2f',
        shgr)
33 printf('\nsensible heat gain through windows is %2f'
        ,sg)
34 disp('sensible heat per adult male is 67.5w and
        latent heat is 55.7w')
35 printf('\nenthalpy rate o is %2f',ho)
36 printf('\nenthalpy rate r is %2f',hr)
37 disp('volume of air infiltrated is 1.628 m*m*m/min')
38 disp('latent heat gain is 902.4w')
39 disp('sensible heat gain is 257.2w')
40 disp('room sensible heat factor is 0.803')

```

Chapter 8

Thermal Engineering

Scilab code Exa 8.1 example 1

```
1 clc
2 //initialisation of variables
3 cc=12000 //btu/h
4 pi=1565 ///watts
5 ra=7 //btu/h/w
6 //CALCULATIONS
7 eer=cc/pi
8 p(1)=cc/ra
9 //RESULTS
10 printf('eer is %2f',eer)
11 printf(' \npower consumption of first unit is
    %2fwatts ',p(1))
```

Scilab code Exa 8.2 example 2

```
1 clc
2 //initialisation of variables
3 t1=278 //temparature in k
```



```

4 t2=300 //temperature in k
5 hf2=21 //kj/kg
6 hfg2=2489.7 //kj/kg
7 h3=113.1 //under 300 k in kj/kg
8 x2=0.8
9 p=3.154 //power
10 //CALCULATIONS
11 cop=t1/(t2-t1)
12 h2=hf2+(x2*hfg2)
13 re=h2-h3
14 pr=p/cop
15 //RESULTS
16 printf('cop is %2f',cop)
17 printf('\npower required is%2fkw/ton of
    refrigeration ',pr)
18 printf('\nrefrigeration effect is %2fkj/kg',re)

```

Scilab code Exa 8.3 example 3

```

1 clc
2 //initialisation of variables
3 t1=253 //temp in k
4 t3=313 //temp in k
5 cp=1.005 //kj/kg
6 r=4 //bar
7 g=1.4
8 //CALCULATIONS
9 t2=(t1*(r)^((g-1)/g))
10 t4=(t3/(r)^((g-1)/g))
11 re=cp*(t1-t4)
12 wi=cp*((t2-t3)-(t1-t4))
13 cop=re/wi
14 ma=(3.5164*10)/re
15 p=ma*wi
16 //RESULTS

```

```

17 printf('cop is %2f',cop)
18 printf('\nmass of refrigeration is %2fkg/s',ma)
19 printf('\npower required to drive the unit is %2fkW',
    ,p)

```

Scilab code Exa 8.4 example 4

```

1
2 clc
3 //initialisation of variables
4 t1=261 //temp in k
5 t3=310 //temp in k
6 cp=1.005 //kJ/kg
7 r=5
8 //CALCULATIONS
9 t2=(t1*(r)^((g-1)/g))
10 t4=(t3/(r)^((g-1)/g))
11 re=cp*(t1-t4)
12 ma=(3.5164*3600)/re
13 woc=cp*(t2-t1)
14 woe=cp*(t3-t4)
15 nw=woc-woe
16 cop1=re/nw
17 cop2=t1/(t3-t1)
18 reff=cop1/cop2
19 //RESULTS
20 printf('temperature at states 2 and 4 are %2fk and
    %2fk',t2,t4)
21 printf('\nmass of air per hour is %2fkg/h',ma)
22 printf('\nnet work required is %2fkj/kg',nw)
23 printf('\ncoefficient of performance is %2f',cop1)
24 printf('\nrelative efficiency is %2f',reff)

```

Scilab code Exa 8.5 example 5

```
1  clc
2  //initialisation of variables
3  h1=176.48 //under -25 degrees temp in kj/kg
4  s1=0.7127 //under -25 degrees temp in kj/kgk
5  h2=215.17 //under 58 degrees temp in kj/kg
6  h3=79.71 //under 45 degrees temp in kj/kg
7  h4=79.71 //under 45 degrees temp in kj/kg
8  no=20 // number of tons
9  //CALCULATIONS
10 w=h2-h1
11 re=h1-h4
12 cop=re/w
13 ha=no*3.5164
14 cr=ha/re
15 pr=cr*w
16 //RESULTS
17 printf('the refrigeration effect is %2fkj/kg',re)
18 printf(' \ncoefficient of performance is %2f',cop)
19 printf(' \npower required is %2fkw',pr)
20 printf(' \ncirculating rate of refrigerant is %2fkg/s
    ',cr)
```

Scilab code Exa 8.6 example 6

```
1  clc
2  //initialisation of variables
3  h1=176.48 //under -25 degrees temp in kj/kg
4  h2=215.17 //kj/kg
5  h4=74.59 //kj/kg
6  //CALCULATIONS
7  re=h1-h4
8  w=h2-h1
9  cop=re/w
```

```
10 //RESULTS
11 printf('the refrigeration effect is %2fkj/kg',re)
12 printf('\ncoefficient of performance is %2f',cop)
```

Scilab code Exa 8.7 example 7

```
1 clc
2 //initialisation of variables
3 h1=179.43 //under -25 degrees temp in kj/kg
4 h2=219.03 //kj/kg
5 h4=74.59 //kj/kg
6 //CALCULATIONS
7 re=h1-h4
8 w=h2-h1
9 cop=re/w
10 //RESULTS
11 printf('the refrigeration effect is %2fkj/kg',re)
12 printf('\ncoefficient of performance is %2f',cop)
```

Scilab code Exa 8.8 example 8

```
1 clc
2 //initialisation of variables
3 h2=1472.6 //kj/kg
4 s2=4.898 //kj/kgk
5 sf1=0.510 //kj/kgk
6 sfg1=5.504 //kj/kgk
7 hf1=126.2 //kj/kg
8 hfg1=1304.3 //kj/kg
9 h4=362.1 //under 38 degrees in kj/kg
10 h2=1472.6 //kj/kg
11 h3=362.1 //under 38 degrees in kj/kg
12 t1=261 //temp in k
```

```

13 t2=311 //temp in k
14 //CALCULATIONS
15 x1=(s2-sf1)/sfg1
16 h1=hf1+(x1*hfg1)
17 re=h1-h4
18 w=h2-h1
19 cop=re/w
20 hr=h2-h3
21 ca=(2*re*50)/(3600*3.5164)
22 pom=100*w/3600
23 ccop=t1/(t2-t1)
24 rff=cop/ccop
25 //RESULTS
26 printf('coefficient of performance is %2f',cop)
27 printf('\nheat rejected in the condenser is%2fkj/kg',
    ,hr)
28 printf('\nrefrigerating effect is%2fkj/kg',re)
29 printf('\ncapacity of motor is%2f froms of
    refrigeration ',ca)
30 printf('\npower of motor is %2fkw',pom)
31 printf('\nrefrigerating befficiency is %2f',rff)

```

Scilab code Exa 8.9 example 9

```

1
2 clc
3 //initialisation of variables
4 hf1=-7.53 //kj/kg
5 hfg1=245.8 //kj/kg
6 x1=0.6
7 sf1=-0.04187 //kj/kgk
8 t1=268 //temp in degrees
9 sf2=0.2513 //kj/kgk
10 hf2=81.25 //kj/kg
11 hfg2=121.5 //kj/kg

```

```

12 t2=298 //temp in k
13 h4=81.25 //under 20 degrees in kj/kg
14 h3=81.25 //under 20 degrees in kj/kg
15 sh=4.2 //kj/kgk
16 lt=335 //kj/kg
17 reff=0.5
18 sfg1= 1 //kj/kg
19 s2= 1 //kj/kg
20 //CALCULATIONS
21 h1=hf1+(x1*hfg1)
22 s1=sf1+(x1*sfg1)
23 x2=((s2-sf2)/hfg2)*t2
24 h2=hf2+(x2*hfg2)
25 re=h1-h4
26 are=re*reff
27 he=sh*10+lt
28 ma=(are*6*60)/he
29 //RESULTS
30 printf('refrigerating effect is%2fkj/kg',re)
31 printf('\nactual refrigerating effect is%2fkj/kg',
    are)
32 printf('\nheat to be extracted to produce 1kg of ice
    is %2fkj/kg of ice',he)
33 printf('\nmass of ice formed is %2fkg/day',ma)

```

Scilab code Exa 8.10 example 10

```

1
2 clc
3 //initialisation of variables
4 ph=13.89 //pressure in bar under 36 degrees temp
5 p1=1.447 //pressure in bar under -26 degrees temp
6 h1=1411.4 //kj/kg
7 s1=5.718 //kj/kgk
8 h2=1561.7 //kj/kg

```

```

9 h3= 150 //kj/kg
10 h4=185.8 //kj/kg
11 h5=1445.5 //kj/kg
12 s5=5.327 //kj/kgk
13 s5=5.327 //kj/kgk
14 h6=1607.6 //kj/kg
15 r=25
16 //CALCULATIONS
17 pi=(p1*ph)^0.5
18 m1=(3.5164*r)/(h1-h4)
19 mh=m1*(h2-h3)/(h5-h1)
20 poc=m1*(h2-h1)
21 pohc=mh*(h6-h5)
22 pr=poc+pohc
23 re=h1-h4
24 wi=(h2-h1)+(h6-h5)
25 cop=re/wi
26 //RESULTS
27 printf('power of lp compressor is %2fkw',poc)
28 printf('\npower of hp compressor is %2fkw',pohc)
29 printf('\ntotal power required is %2fkw',pr)
30 printf('\nrefrigerating effect is%2fkj/kg',re)
31 printf('\ncoefficient of performance is %2f',cop)

```

Scilab code Exa 8.11 example 11

```

1 clc
2 //initialisation of variables
3 h1=1411.4 //kj/kg
4 s1=5.718 //kj/kgk
5 s2=5.718 //kj/kgk
6 h2=1755.7 //kj/kg
7 h4=352.3 //under 13.89 bar in kj/kg
8 h3=352.3 //under 13.89 bar in kj/kg
9 //CALCULATIONS

```

```

10 m=(3.5164*25)/(h1-h4)
11 poc=m*(h2-h1)
12 cop=(h1-h4)/(h2-h1)
13 //RESULTS
14 printf('mass flow rate of refrigerant is %2fkg/s',m)
15 printf('\ncoefficient of performance is %2f',cop)
16 printf('\npower of compressor is %2fkW',poc)

```

Scilab code Exa 8.12 example 12

```

1 clc
2 //initialisation of variables
3 h1=178.73 //under -20 degrees in kj/kg
4 h5=185.66 //under 5 degrees in kj/kg
5 h3=79.71 //under 10.84 degrees in kj/kg
6 h6=79.71 //under 10.84 degrees in kj/kg
7 h4=79.71 //under 10.84 degrees in kj/kg
8 h2=219.33 //kj/kg
9 //CALCULATIONS
10 m1=(7*211)/(h1-h4)
11 mh=(5*211)/(h5-h4)
12 h8=((m1*h1)+(mh*h5))/(m1+mh)
13 poc=(m1+mh)*(h2-h8)
14 cop=(12*211)/poc
15 //RESULTS
16 printf('power of compressor is %2fkj/min',poc)
17 printf('\nrefrigerant flow rate is %2fkg/min',mh)
18 printf('\ncoefficient of performance is %2f',cop)

```

Scilab code Exa 8.13 example 13

```

1 clc
2 //initialisation of variables

```



```

3 h1=185.38 //under -5 degrees temp in kj/kg
4 s1=0.6991 //nder -5 degrees temp in kj/kgk
5 ps2=7.449 //under 30 degrees in bar
6 s2=0.6991 //under 30 degrees in bar
7 h2=203.9 //kj/kg
8 h3=64.59 //kj/kg
9 h4=64.59 //kj/kg
10 //CALCULATIONS
11 he=h2-h3
12 wi=h2-h1
13 cop1=he/wi
14 mf=84400/he
15 pr=(mf/3600)*(wi)
16 coe=pr*1
17 //RESULTS
18 printf('coefficient of performance is %2f',cop1)
19 printf('\nmass flow rate of refrigerant is %2fkg/h',
mf)
20 printf('\npower required is %2fkW',pr)
21 printf('\ncost of electricity is %2frs',coe)

```

Scilab code Exa 8.14 example 14

```

1 clc
2 //initialisation of variables
3 t1=1100 //K
4 t2=275 //K
5 g=1.4
6 pa=101.32
7 qs=250 //kj/kg
8 r=0.287 //kj/kgK
9 //CALCULATIONS
10 p1=(t1/t2)^(3.5)*pa //(g/g-1)=3.5
11 pb=2.2075*p1
12 va=(r*t2)/pa

```

```
13 vb=(r*t1)/pb
14 mep=(0.75*qs)/(va-vb)
15 printf('mean effective pressure is %2f units ',mep)
```

Scilab code Exa 8.15 example 15

```
1  clc
2  //initialisation of variables
3  ps2=0.008129 //under 4 degree temp in bar
4  ps3=0.047534 //under32 degree temp in bar
5  v=0.75 //volume in m*m*m
6  vf=0.001
7  h1=50.4 //under 12 degree temp in kj/kg
8  h2=16.8 //kj/kg
9  hf3=16.8 //kj/kg
10 hfg3=2492.1 //kj/kg
11 x3=0.98
12 vg3=157.27 //under 4 degree temperature
13 //CALCULATIONS
14 pr=ps3/ps2
15 mfr=v/vf
16 re=mfr*(h1-h2)
17 h3=hf3+(x3*hfg3)
18 mf3=re/(h3-h1)
19 vv=mf3*x3*vg3
20 //RESULTS
21 disp('pressures in flash chamber are ps2=0.008129
      and ps3=0.047534 ')
22 printf('\npressure ratio is %2f',pr)
23 printf('\nthe refrigeration effect is %2fkj/kg',re)
24 printf('\namount of makeup water is %2fkg/min',mf3)
25 printf('\nvolume of water entering the ejector is
      %2fm*m*m/min ',vv)
```

Scilab code Exa 8.16 example 16

```
1  clc
2  //initialisation of variables
3  h1=272.763 //under 300 k temp in kj/kg
4  s1=6.4125 //under 300 k temp in kj/kg
5  h2=230.347 //under 200 k temp in kj/kg1
6  s2=4.9216 //under 300 k temp in kj/kg
7  hf=-133.347 //kj/kg
8  t1=300 //temp in k
9  //CALCULATIONS
10 y=(h1-h2)/(h1-hf)
11 mw=(t1*(s2-s1))-(h2-h1)
12 x=mw/0.1044
13 //RESULTS
14 printf('fraction of oxygen condensed is %2f',y)
15 printf('\nwork required is %2f',x) //answer is wrong
    in tb
```

Scilab code Exa 8.19 example 19

```
1  clc
2  //initialisation of variables
3  t1=300 //temp in k
4  sf=2.9409 //kj/kgk
5  s1=6.44125 //kj/kgk
6  hf=-133.347 //kj/kg
7  h1=272.763 //kj/kg
8  w=-4690.5
9  //CALCULATIONS
10 mw=(t1*(sf-s1))-(hf-h1)
11 fom=mw/w
```

```
12 //RESULTS
13 printf('minimum work is %2fkj/kg of o2 liquefied',mw
    )
14 printf('\nfigure of merit is %2f',fom)
15 //no 8.17 and 8.19 in tb print mistake
```

Chapter 9

Thermal Engineering

Scilab code Exa 9.1 example 1

```
1  clc
2  //initialisation of variables
3  t1=305 //temp in k
4  r=0.287 //kj/kg
5  p2=6 //pressure in bar
6  p1=1.013 //pressure in bar
7  g=1.4 //const value
8  n=1.28
9  v1=100 //volume
10 //CALCULATIONS
11 rp=(p2/p1)
12 wiso=r*t1*log(p2/p1)
13 wadia=(g/(g-1))*r*t1*0.6623
14 wpoly=(n/(n-1))*r*t1*0.4756
15 m=(p1*v1*100)/(r*t1)
16 ipr=(wiso*m)/60
17 apr=(wadia*m)/60
18 //RESULTS
19 printf('work for isothermal compression is %2fknm/kg',
        ,wiso)
20 printf('\nwork for adiabatic compression is %2fknm/
```

```

    kg',wadia)
21 printf('\nwork for polytropic compression is %2fknm/
    kg',wpoly)
22 printf('\nmass of air compressed is %2fkg/min',m)
23 printf('\nisothermal power required is %2fkw',ipr)
24 printf('\nadiabatic power required is %2fkw',apr)

```

Scilab code Exa 9.2 example 2

```

1 clc
2 //initialisation of variables
3 p2=135 //bar pressure
4 p1=1 //bar pressure
5 x=5 //x=p2/p1
6 //CALCULATIONS
7 s=log(p2)/log(x)
8 rp=(p2/p1)^0.25
9 //RESULTS
10 printf('s is %2f',s)
11 printf('\nrp is %2f',rp)
12 disp('number of stages are 4')
13 disp('1st intermediate pressure is 3.4087 bar')
14 disp('2nd intermediate pressure is 11.619 bar')
15 disp('3rd intermediate pressure is 39.605 bar')

```

Scilab code Exa 9.3 example 3

```

1 clc
2 //initialisation of variables
3 p2=3.24 //pressure in bar
4 p1=1 //pressure in bar
5 v1=16 //volume in m*m*m
6 n=1.35

```

```

7 rp=3.24 //pressure
8 r=10.5
9 t1=294 //temparature in k
10 t2=294 //temparature in k
11 cp=1.005 //kj/kg
12 rx=0.287
13 //CALCULATIONS
14 w1=(2*n/(n-1))*p1*v1*100*0.35630 //(3.24)^0.2592-1
15 w2=(n/(n-1))*p1*v1*100*0.8396 //(10.5)^0.2592-1
16 pr1=w1/60
17 pr2=w2/60
18 tb=t1*(r)^(n-1/n)
19 t3=t2*(rp)^((n-1)/n)
20 m=(p1*v1*100)/(rx*t1)
21 hr=m*cp*(t3-t2)
22 ma=hr/(4.18*25)
23 //RESULTS
24 printf('minimum power required are %2fkW and %2fkW',
        pr1,pr2)
25 printf('\nmass of air compressed is %2fkg/min',m)
26 printf('\nheat rejected by air compressor is %2fkj/
        min',hr)
27 printf('\nmass of water is %2fkg/min',ma)

```

Scilab code Exa 9.4 example 4

```

1 clc
2 //initialisation of variables
3 p2=4.08 //pressure in bar
4 p1=1 //pressure in bar
5 n=1.22
6 r=0.287
7 p=1.01325 //pressure in bar
8 v=145 //volume
9 t=288 //temparature in k

```

```

10 p3=17.5 //pressure in bar
11 t1=307 //temp in k
12 t2=313 //temp in k
13 //CALCULATIONS
14 wlp=5.54*r*t1*((p2/p1)^((n-1)/n))-1)
15 whp=5.54*r*t2*((p2/p1)^((n-1)/n))-1)
16 w=wlp+whp
17 m=(p*v)/(r*t)
18 pr=(w*m)/60
19 p2=(p1*p3)^0.5
20 x=(p2)^0.5 //x=d1/d2
21 //RESULTS
22 printf('total work required is %2fknm/kg',w)
23 printf('\nmass of free air is %2fkg/min',m)
24 printf('\npower required to drive the compressor is
    %2fkw',pr)
25 printf('\nratio of cylinder diameters is %2f',x)

```

Scilab code Exa 9.5 example 5

```

1 clc
2 //initialisation of variables
3 c1=0.05 //percentage
4 c2=0.10 //percentage
5 c3=0.20 //percentage
6 rp=10
7 //CALCULATIONS
8 eff1=(1+c1-c1*(rp)^(0.78125))
9 eff2=(1+c2-c2*(rp)^(0.78125))
10 eff3=(1+c3-c3*(rp)^(0.78125))
11 //RESULTS
12 printf('volumetric efficiency 1 is %2f',eff1)
13 printf('\nvolumetric efficiency 2 is %2f',eff2)
14 printf('\nvolumetric efficiency 3 is %2f',eff3)

```

Scilab code Exa 9.6 example 6

```
1  clc
2  //initialisation of variables
3  d=0.2 //diameter in m
4  lc=0.01 //linear clearance
5  l=0.3 //lenght
6  rp=7
7  n=1.25
8  pi=(22/7)
9  //CALCULATIONS
10 cv=((pi/4)*((d)^2)*lc)
11 sv=((pi/4)*(d)^2*l)
12 cr=cv/sv
13 veff=(1+cr-cr*(rp)^(1/n))
14 x=veff*sv
15 //RESULTS
16 printf('clearance ratio is %2f',cr)
17 printf('\nvolumetric efficiency is %2f',veff)
18 printf('\nvolume of air taken in is %2fm*m*/stroke',
    x)
```

Scilab code Exa 9.7 example 7

```
1  clc
2  //initialisation of variables
3  n=1.2
4  r=0.287
5  t1=310 //temperature in degrees
6  p2=7 //pressure in bar
7  p1=1 //pressure in bar
8  //CALCULATIONS
```

```

9 rp=(p2/p1)
10 wr=((n/(n-1))*r*t1*((rp)^((n-1)/n)-1))
11 //RESULTS
12 disp('volumetric efficiency is 0.797')
13 disp('volumetric efficiency referred to atmospheric
    conditions is 0.73')
14 printf('work required is %2fknm/kg',wr)

```

Scilab code Exa 9.8 example 8

```

1 clc
2 //initialisation of variables
3 veff=0.8 //efficiency
4 rp=7
5 n=1.2 //constant value
6 pi=(22/7)
7 //CALCULATIONS
8 c=(veff-1)/(1-(rp)^(1/n))
9 vs=2/c
10 d=((4*vs)/pi)^(1/3)
11 //RESULTS
12 printf('stroke volume is %2fm*m*m',vs)
13 printf('\nlength of stroke is %2fm',d)

```

Scilab code Exa 9.9 example 9

```

1 clc
2 //initialisation of variables
3 sp=1400 //speed in revolutions per min
4 ma=15 //mass in kgs
5 r=0.287
6 p1=1 //pressure in bar
7 t1=303 //temparature in k

```

```

8 p2=7 //pressure in bar
9 c=0.05 //clearance volume/stroke volume
10 pi=(22/7)
11 n=1.2
12 m1=15
13 meff=0.85 //mechanical efficinecy
14 //CALCULATIONS
15 rp=(p2/p1)
16 m=ma/sp
17 va=(m1*r*t1)/(p1*100)
18 eff1=(1+c-c*(rp)^(1/n))
19 vs=va/eff1
20 d1=((4*vs)/pi)^(1/3)
21 pr=((n/(n-1))*m1*r*t1*((rp)^((n-1)/n)-1))/60
22 prs=pr/meff
23 d2=((prs*4)/(7*100*pi*700))^0.333
24 //RESULTS
25 printf('volumetric efficiency is %2f',eff1)
26 printf('\nlength of the stroke is %2fm',d1)
27 printf('\nindicated power is %2fkW',pr)
28 printf('\npower required at the shaft of the
    compressor is %2fkW',prs)
29 printf('\ndiameter of the piston is %2fm',d2)

```

Scilab code Exa 9.10 example 10

```

1 clc
2 //initialisation of variables
3 sp=200 //mean speed m/s
4 //CALCULATIONS
5 d=(21/(0.7773*1.18*200))^0.5
6 l=1.5*d
7 s=200/(3*d)
8 //RESULTS
9 disp('volumetric efficiency is 0.7773')

```

```

10 printf('\ndiameter is %2fm',d)
11 printf('\nstroke is %2fm',l)
12 printf('\nspeed of compressor is %2frev/min',s)

```

Scilab code Exa 9.11 example 11

```

1
2 clc
3 //initialisation of variables
4 r=0.287
5 p=1.01325 //pressure in bar
6 v=5 //volume in m*m*m
7 t=288 //temparature in k
8 t1=303 //temperature in k
9 t2=403 //temperature in k
10 p2=4.08 //pressure in bar
11 p1=0.98 //pressure in bar
12 p3=17 //pressure in bar
13 n=1.25
14 c=0.06 //clearance volume by swept volume
15 //CALCULATIONS
16 m=(p*v)/(r*t)
17 rp=p2/p1
18 t2s=(t1*(p2/p1)^((n-1)/n))
19 wr=(n/n-1)*r*(t2-t1)
20 wc=2*wr
21 veff=(1+c-c*(rp)^(1/n))
22 x=(p*100*v*t1)/(p1*100*t) //x=(v1-v4)
23 vs=x/veff
24 vsc=vs/125
25 d1=((4*vsc)/%pi)^(1/3)
26 //RESULTS
27 printf('volumetric efficiency is %2f',veff)
28 printf('\nstroke volume is %2fm*m*m/min',vs)
29 printf('\nstroke volume per cycle is %2fm*m*m',vsc)

```

```
30 printf('\nstoke of piston is %2f',d1)
```

Scilab code Exa 9.12 example12

```
1  clc
2  //initialisation of variables
3  t1=303 //temparature in k
4  p2=4.08 //pressure in bar
5  p1=1 //pressure in bar
6  t5=303 //temperature in k
7  x=0.3247 //x=v2/v1 where the relation is v2=v1*(1/rp
      )^1/n
8  y=0.0385 //y=v3/v1
9  vo=0.2862 //vo=volume of air delivered/v1
10 vf=0.8299 //vf=vome of free air /v1
11 n=1.25
12 p3=17.5 //pressure in bar
13 r=0.287
14 tatm=2911 //temp in k
15 patm=1.02 //pressure in bar
16 w=291
17 //CALCULATIONS
18 t2=(t1*(p2/p1)^((n-1)/n))
19 veff=vf/(1-y)
20 a=(r*(t2-t1)*5)
21 t3=(t1*(p3/p2)^((n-1)/n))
22 hp=(5*r*(t3-t1))
23 iso=(r*tatm*log(p3/patm))/10 //its ln
24 ieff=iso/w
25 //RESULTS
26 printf('volumetric efficiency is %2f',veff)
27 printf('\nwork required for lp cylinder is %2f',a)
28 printf('\nwork required for hp cylinder is %2f',hp)
29 printf('\nwork required for isothermal is %2f',iso)
30 printf('\nisothermal efficiency is %2f',ieff)
```

Scilab code Exa 9.13 exmaple 13

```
1 clc
2 //initialisation of variables
3 p2=1.5 //pressure in bar
4 p1=1 //pressure in bar
5 v=0.05 //volume in m*m*m
6 g=1.4
7 r=1.4
8 n=120 //number of cycles
9 //CALCULATIONS
10 wa=v*(p2-p1)*100
11 wi=3.5*100*p1*v*(((p2/p1)^((r-1)/r))-1)
12 reff=wi/wa
13 vo=v/4
14 pr=wa*n/60
15 //RESULTS
16 printf('roots efficiency is %2f',reff)
17 printf(' \nvolume of air is %2fm*m*m/cycle ',vo)
18 printf(' \npower required is %2fkw ',pr)
```

Scilab code Exa 9.14 example 14

```
1 clc
2 //initialisation of variables
3 p2=1.5 //pressure in bar
4 p1=1 //pressure in bar
5 v=0.05 //volume in m*m*m
6 x=0.35 //increase in pressure
7 g=1.4
8 r=1.4
```

```

 9 n=120 //number of cycles
10 //CALCULATIONS
11 wa=v*(p2-p1)*100
12 wi1=3.5*100*p1*v*(((p2/p1)^((r-1)/r))-1)
13 ceff=wi1/wa
14 vo=v/4
15 pr=wa*n/60
16 prs=x*(p2-p1)
17 p3=p1+prs
18 wi2=3.5*100*p1*v*(((p3/p1)^((r-1)/r))-1)
19 vi=v*(p1/p3)^(1/g)
20 w2=vi*(p2-p3)*100
21 tw=w2+wi2
22 comeff=wi1/tw
23 po=tw*2
24 //RESULTS
25 printf('compressor efficiency is %2f',ceff)
26 printf('\nwork required for internal compression is
    %2fknm/rev ',wi2)
27 printf('\npower required is %2fkW',pr)
28 printf('\ncompressor efficiency 2 is %2f',comeff)
29 printf('\npower required 2 is %2fkW',po)

```

Scilab code Exa 9.15 example 15

```

1 clc
2 //initialisation of variables
3 t1=295 //temp in k
4 p1=1.02 //pressure in bar
5 p2=7.14 //pressure in bar
6 cp=1.005 //kJ/kg
7 g=1.4
8 wr=250 //kJ/kg
9 //CALCULATIONS
10 t2s=t1*(p2/p1)^((g-1)/g)

```

```

11 wi=cp*(t2s-t1)
12 ieff=wi/wr
13 t2=(wr/cp)+t1
14 //RESULTS
15 printf('isentropic work is %2fkj/kg',wi)
16 printf('\nisentropic efficiency is %2f',ieff)
17 printf('\ntemperature 2 is %2fk',t2)
18 disp('index of compression is 1.46')

```

Scilab code Exa 9.16 example16

```

1
2 clc
3 //initialisation of variables
4 t1=310 //temp in k
5 p1=1 //pressure in bar
6 p2=4 //pressure in bar
7 cp=1.005 //kj/kg
8 v1=28 //m*m*m volume
9 r=0.287
10 ce=0.7 //compression efficiency
11 g= 32.2 //ft/sec^2
12 //CALCULATIONS
13 t2s=t1*(p2/p1)^((g-1)/g)
14 wi=cp*(t2s-t1)
15 m=(p1*v1*100)/(r*t1)
16 apr=(m*wi)/60
17 iei=wi/ce
18 //RESULTS
19 printf('isentropic work is %2f',apr)
20 printf('\nadiabatic power required is %2f',m)
21 printf('\nindicated enthalpy increase is %2f',iei)

```

Scilab code Exa 9.17 example 17

```
1
2 clc
3 //initialisation of variables
4 p2=6 //prpressure in bar
5 p1=1 //pressure in bar
6 t1=313 //temp in k
7 a1=45 //angle in degrees
8 a2=10 //angle in degrees
9 a3=55 //angle in degrees
10 r=1.4
11 cp=1.005 //kj/kg
12 ieff=0.85 //isentropic efficiency
13 c=200 //m/s
14 //CALCULATIONS
15 t2s=(t1*(p2/p1)^((r-1)/r))
16 t2=(((t2s-t1)/ieff)+t1)
17 w=cp*(t2-t1)
18 cro=(c*(sin(45*(%pi/180))/sin(55*(%pi/180))))
19 cv=c-cro
20 n=w/cv
21 //RESULTS
22 printf('actual work is %2fkj/kg',w)
23 printf('\\nchange in whirl velocities is %2fkj/kg/
    stage',cv)
24 printf('\\nnumber of stages is %2fstages',n)
```
