Scilab Textbook Companion for Applied Thermodynamics and Engineering by T. D. Eastop and A. Mcconkey[1]

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Book Description

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

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Chapter 1

Introduction and the first law of thermodynamics

Scilab code Exa 1.1 chapter 1 example 1

```

clc;
p=3;//bar
v=0.18;//m^2/kg
p2=0.6;//bar

c=p*v^2;

v2=(c/p2)^0.5;

W=-c*(10^5)*[(1/v)-(1/v2)];
disp("Work done by the fluid is:");
disp("N m/kg",-W);
//Answers vary more than than +/-5 :
//Answers in the textbook is wrong
```

Scilab code Exa 1.2 chapter 1 example 2

```
clc;
p1=20;//bar
v1=0.05;//m^3
v2=0.1;//m^3
p2=p1*[(v1/v2)^2];//bar

W_12=-10^5*p1*(v1^2)*((1/v1)-(1/v2));

W_23=10^5*p2*(v2-v1);

//work done from 3-1 is zero as the piston is locked
    in position.

disp("The net work done by the fluid is:");
W=-(W_12+W_23)
disp("N m",W)
```

Scilab code Exa 1.3 chapter 1 example 3

```
clc;

heat_supplied=2800;//kJ/kg
heat_rejected=2100;//kJ/kg
sigma_dQ=heat_supplied-heat_rejected;

work_done=1000;
work_reqr=5;
sigma_dW=work_reqr-work_done;

m=-sigma_dW/sigma_dQ
disp("steam mass flow rate required is:");
disp("kg/s",m)
```

Scilab code Exa 1.4 chapter 1 example 4

```
clc;
Q=-45;//kJ/kg
W=90;//kJ/kg

u2_u1=Q+W;
disp("gain in internal energy is:");
disp("kJ/kg",u2_u1);
```

Scilab code Exa 1.5 chapter 1 example 5

```
clc;
W=-100;//kJ/kg
u2=200;//kJ/kg
u1=420;//kJ/kg

Q=u2-u1-W;
disp("heat rejected by the air is:");
disp("kJ/kg",-Q);
```

Scilab code Exa 1.6 chapter 1 example 6

```
clc;
c1=60;//m/s
W=-14000;//kW
m=17;//kg/s
h1=1200;//kJ/kg
h2=360;//kJ/kg
```

```

KE_I=c1^2/2000;//kJ/kg
KE_O=(2.5^2)*KE_I;
//c2=2.5*c1;

Q=m*{[h2+(KE_I/1000)]-[h1+(KE_O/1000)]}-W;
disp("Heat rejected:");
disp("kW",-Q);

v=0.5;//m^2
A=m*v/c1;
disp("inlet area is");
disp("m^2",A)
```

Scilab code Exa 1.7 chapter 1 example 7

```
clc;
c1=6;//m/s
c2=4.5;//m^2
p1=10^5;//bar
p2=6.9*10^5;//bar
v1=0.85;//m^3/kg
v2=0.16;//m^3/kg
u2_u1=88;//kJ/kg
m=0.4;//kg/s
Q=-59;//kW

KI=c1^2/2000;
KO=c2^2/2000;

W=m*{(u2_u1)+(p2*v2-p1*v1)+(KO-KI)}-Q;
disp("powar input required is:");
disp("kW",W/1000);

A1=m*(v1/c1);
```

```
disp("inlet pipe cross section area is:");
disp("m^2",A1);

A2=m*(v2/c2);
disp("outlet pipe cross section area is:");
disp("m^2",A2);
```

Chapter 2

The Working Fluid

Scilab code Exa 2.1 1

```
clc;

x=0.9;
vg=0.1104;
v=x*vg;
disp("specific volume is:");
disp("m^3/kg",v)

hf=885;
h_fg=1912;
h=hf+x*h_fg;
disp("specific enthalpy is:");
disp("kJ/kg",h);

uf=883;
ug=2598;
u=(1-x)*uf+x*ug;
disp("specific internal energy is:");
disp("kJ/kg",u);
```

Scilab code Exa 2.2 2

```
clc;

p=7;//bar
h=2600;//kJ/kg
hf=697;//kJ/kg
h_fg=2067;//kJ/kg
x=(h-hf)/h_fg;
disp("dryness fraction is:");
disp(x);

vg=0.2728;
v=x*vg;
disp("specific volume is:");
disp("m^3/kg",v);

uf=696;
ug=2573;
u=(1-x)*uf+x*ug;
disp("specific internal energy is:");
disp("kJ/kg",u)
```

Scilab code Exa 2.3 3

```
clc;

//at 110 bar, vg=0.01598m^3/kg which is less than
   the actual specific volume of 0.0196m^3/kg
//hence it is superheated

v=0.0196;//m^3/kg
```

```
p=110;//bar
//from tables
h=2889;//kJ/kg
t=350;//C
disp("temperature is:");
disp("C",t);
u=h-(p*10^5)*(v/1000);
disp("enthalpy is:");
disp("kJ/kg",u);
disp("specific internal energy is:");
disp("kJ/kg",u);
```

Scilab code Exa 2.4 4

```
clc;

p=150;//bar
h=3309;//kJ/kg

//from tables
hg=2611;//kJ/kg
//hence the steam is superheated.

//from table
t=500;//C
v=0.02078;//m^3/kg
disp("temperature is:");
disp("C",t);
disp("specific volume is:");
disp("m^3/kg",v);

u=h-(p*10^5)*(v/1000);
disp("specific internal energy is:")
disp("kJ/kg",u)
```

Scilab code Exa 2.5 5

```
clc;

//from tables;
v_a=0.1115;//m^3/kg
p_b=20;//bar
v_d=0.4743;//m^3/kg

hf=763;//kJ/kg
h=2650;//kJ/kg
h_fg=2015;//kJ/kg
x=(h-hf)/h_fg;
vg=0.1944;//m^3/kg
v_c=x*vg;

clf();
x=linspace(0.05,0.5,1000);
y=(0.09957*20)*((x)^(-1));
plot2d(x,y,style=1);

y=20;
plot(x,y)

y=10;
plot(x,y);

y=(0.4743*6)*((x)^(-1));
plot2d(x,y,style=4);

y=(0.1115*20)*((x)^(-1));
plot2d(x,y,style=2);

y=6;
```

```
plot2d(x,y,style=4)
```

Scilab code Exa 2.6 6

```
clc;
//from tables;


v_a=0.1115;//m^3/kg
u_a=2681;//kJ/kg
//steami s super heated
disp("internal energy of part a is:");
disp("kJ/kg",u_a);

p_b=20;//bar
u_b=2600;//kJ/kg
disp("internal energy of part b is:");
disp("kJ/kg",u_b);

v_d=0.4743;//m^3/kg
u_d=2881;//kJ/kg
disp("internal energy of part d is:");
disp("kJ/kg",u_d);

hf=763;//kJ/kg
h=2650;//kJ/kg
h_fg=2015;//kJ/kg
x=(h-hf)/h_fg;
ul=762;//kJ/kg
ug=2584;//kJ/kg
u=(1-x)*ul+x*ug;
disp("internal energy of part c is:");
disp("kJ/kg",u);
```

Scilab code Exa 2.7 7

```
clc;

//for part (i)
hf=89.8;//kJ/kg
x=0.95;
h_fg=(1420-89.8);//kJ/kg
hi=hf+x*h_fg;//kJ/kg
disp("enthalpy of part (i)");
disp("kJ/kg",hi);

//for part (ii)
//ammonia heated by (60-20) K
x=40/50;
hf=1462.6;//kJ/kg
h_fg=(1597.2-1462.6);//kJ/kg
hii=hf+x*h_fg;
disp("enthalpy of part (ii)");
disp("kJ/kg",hii);
```

Scilab code Exa 2.8 8

```
clc;
v1=0.2*10^5;//m^3
p1=1.013;//bar
T1=15+273;//C
w=0.2;//kg
m=28;//kg/k mole
R_=8314.5;//N m/K

R=R_/m;
```

```
m1=p1*v1/(R*T1);

m2=0.20+.237;
//T2=T1 &  v2=v1
p2=m2*R*T1/v1
disp("the new pressure is:");
disp("bar",p2)
```

Scilab code Exa 2.9 9

```
clc;
p1=7*10^5;//bar
V1=0.003;//m^3/kg
m=0.01;
T1=131+273;//K
R_=8314.5;

R=p1*V1/(m*T1);

m_=R_/R;
disp("tha molar mass of tha gas is:");
disp("kg/k mole",m_);

p2=1*10^5;//bar
V2=0.02;//m^3
m=0.01;
R=520;
T2=p2*V2/(m*R);
disp("final temperature is:");
disp("C",T2-273);
```

Scilab code Exa 2.10 10

```
clc;
cp=0.846;//kJ/kg K
cv=0.657;//kJ/kg K

R=(cp-cv)*1000;
disp("the gas constant is:");
disp("N m/kg K",R);

R_=8314.5
m=R_/R;
disp("molar mass of the gas:");
disp("kg/k mole",m);
```

Scilab code Exa 2.11 11

```
clc;
R_=8314.5;
m_=26;//kg/k mole
y=1.26;

R=R_/m_;
cv=R/[(y-1)*1000];
cp=y*cv;

T1=315+273;//K
p2=1.5;//bar
p1=3;//bar
T2=T1*p2/p1;

Q=cv*(T2-T1);
disp("heat rejected in part a:");
disp("kJ/kg",-Q);

T2=20;//K
T1=280;//K
```

```
m_=1;
Q=m_*cp*(T2-T1);
disp("heat rejected in part b");
disp("kW",-Q);
```

Chapter 3

Reversible and Irreversible processes

Scilab code Exa 3.1 1

```
clc
//at 2bar
h1=2707;//kJ/kg
hg=h1;
m1=0.05;//kg
v=0.0658;//m^3
v2=v/m1;//m^3/kg
h2=3072;//kJ/kg
p=2*10^5;
v1=0.8856

Q=m1*(h2-h1);
disp("heat suppleid is:");
disp("kJ",Q);

W=-p*(v2-v1);
disp("work done is:");
disp("N m/kg",W);

```

```
//part (ii)
p2=p;
R=0.287;
T2=p2*v/(m1*R*1000);
cp=1.005;
T1=130+273;
Q=m1*cp*(T2-T1);
disp("heat supplie in part (ii)");
disp("kJ",Q);

W=-R*(T2-T1)*m1;
disp("work done by the mass of gas presint:");
disp("kJ",W);
```

Scilab code Exa 3.2 2

```
clc;
x=0.9;
uf=696;
ug=2573;
u1=(1-x)*uf+x*ug;
//similarly
u2=2602.8;

disp("chang of internal energy is:");
disp("kJ/kg",u2-u1);

hf=697;
h_fg=2067;
h1=hf+x*h_fg;
h2=2803;//kJ/kg
disp("change in enthalpy:");
disp("kJ/kg",h2-h1);

Q=547;
```

```
W=(u2-u1)-Q;
disp("Work done is:");
disp("kJ/kg",W)
```

Scilab code Exa 3.3 3

```
clc;
R_=8.3145;
m_=28;
R=R_/m_;
T=273+20;
p2=4.2;//bar
p1=1.01;//bar
W=R*T*log(p2/p1);
disp("work input:");
disp("kJ/kg",W);

disp("heat rejected:");
disp("kJ/kg",W);//Q+W=0
```

Scilab code Exa 3.4 3

```
clc;
h1=3017;//kJ/kg
v1=0.02453;//m^3/kg
p1=100;//bar
u1=h1-p1*v1*10^5/1000;
ug=2602;//kJ/kg
u2=ug;
W=u2-u1;
disp("work done by system is :");
disp("kJ/kg",-W)
```

Scilab code Exa 3.5 5

```
clc;
T1=295;//C
p1=1.02;//bar
p2=6.8;//bar
y=1.4;
v1=0.015;//m^3
cv=0.718;
R=0.287

T2=T1*(p2/p1)^((y-1)/y);
disp("final temperature is:");
disp("k",T2);

v2=v1*{(p1/p2)^(1/y)};
disp("final volume is:");
disp("m^3",v2);

w=cv*(T2-T1);
m=p1*v1*10^5/(10^3*R*T1);
W=w*m;
disp("total work done is:");
disp("kJ",W)
```

Scilab code Exa 3.6 6

```
clc;
p1=1;//bar
p2=10;//bar
n=1.1;
v1=0.16;//m^3
```

```
v2=v1*(p1/p2)^(1/n);

W=(p2*v2-p1*v1)*10^5/[10^3*(n-1)];
disp("work done by the refrigerant is:");
disp("kJ",W);

hg1=174.2;
u1=hg1-(p1*10^5*v1/10^3);

hg2=203.8;//kJ/kg
vg2=0.018;//m^3
v=0.02;//m^3
h=224;//kJ/kg
h2=hg2+(v2-vg2)*(h-hg2)/(v-vg2);
u2=h2-(p2*10^5*v2/10^3)

Q=-W+(u2-u1);
disp("heat transferred is:");
disp("kJ/kg",Q)
```

Scilab code Exa 3.7 7

```
clc;
T1=300;//K
p2=6.6;//bar
p1=1.1;//bar
n=1.3;
T2=T1*[(p2/p1)^((n-1)/n)];

R_=8.3145;
m_=30;
R=R_/m_;

cp=2.10;
```

```
cv=cp-R;
y=cp/cv;
W=R*(T2-T1)/(n-1);
Q=(n-y)/(y-1)
disp("heat supplied is:");
disp("kJ/kg",Q);

m_=40;
R=R_/m_;
cp=0.520;//kJ/kg
cv=cp-R;
y=cp/cv;
W=R*(T1-T2)/(n-1);
Q=[(n-y)/(y-1)]*W
disp("heat rejected is:")
disp("kJ/kg",Q)
```

Scilab code Exa 3.8 8

```
clc;
p1=7;//bar
p2=1;//bar
y=1.333;
T1=923;//K
T2=T1/[(p1/p2)^((y-1)/y)]

cp=1.11;
c2=45;
c1=9;
W=cp*(T2-T1)+[(c2^2-c1^2)/(2*10^3)];
disp("powar output is");
disp("kW",-W)
```

Scilab code Exa 3.9 9

```
clc;
V1=1;//m^3
VA=1;//m^3
VB=1;//m^3
V2=VA+VB;
p1=20;//BAR
p2=p1*(V1/V2);
disp("final pressure is:");
disp("bar",p2);
```

Scilab code Exa 3.10 10

```
clc;
h3=2716.4;//kJ/kg
hf2=640;
h_fg2=2109;
x2=(h3-hf2)/(h_fg2);

flow_rate=9;
m_w2=(1-x2)*(flow_rate);
mass_water=0.5;
m_w1=m_w2+mass_water

flow_rate_dry=mass_water+flow_rate-m_w1;
x1=flow_rate_dry/(mass_water+flow_rate);
disp("fraction is:");
disp(x1)
```

Scilab code Exa 3.11 11

```
clc;
x=0.9;
uf=511;
ug=2531;
u=uf*(1-x)+(ug*x);
V=10;
vg=0.8461;
v=x*vg;
m=V/v;
h=2944;
u2=2640;
v2=0.3522;
m2=V/v2;
Q=m2*u2-m*u-h*(m2-m);
disp("heat rejected is;");
disp("kJ",-Q)
//Answers vary more than than +/-5 :
//Answers in the textbook is wrong
```

Scilab code Exa 3.12 12

```
clc;
p=15;//bar
V=6;//m^3;
R=0.287;
T=313.5;
y=1.4

m=p*V/(R*T);

p2=12;//bar
T2=T/[(p/p2)^((y-1)/y)];
m2=p2*V*10^5/(R*T2*10^3);

disp("mass of air left");
```

```
disp("kg",m2)
```

Chapter 4

The Second Law

Scilab code Exa 4.1 1

```
clc;
s1=6.5;
sf1=1.992;
sfg1=4.717;
x=(s1-sf1)/sfg1;

hf1=697;//kJ/kg
hfg1=2067;//kJ/kg
h1=hf1+x*hfg1;

h2=2995;//kJ/kg
Q=h2-h1;

disp("heat supplied:");
disp("kJ/kg",Q)
```

Scilab code Exa 4.2 2

```
clc;
v=0.025;//m^3
s=0.02994;//m^3/kg
m=v/s;

h1=2990;//
p1=s/10^3;
v1=80*10^5;
u1=h1-p1*v1;

v2=s;
vg1=0.03944;
x1=v2/vg1;

uf2=1149;
ug2=2597;
u2=(1-x1)*uf2+x1*ug2;

Q=m*(u2-u1);
disp("kJ",-Q,"rejected heat:")
```

Scilab code Exa 4.3 3

```
clc;
p=1.05;//bar
V=0.02;//m^3
R=0.287;//m^3
T=15+273;//K
m=p*V*10^5/(R*T*10^3);

p2=4.2;//bar
T2=p2*T/p;

cv=0.714;
Q=m*cv*(T2-T);
```

```
Q_12=Q;

cp=1.005;
T3=288;//K
Q_23=m*cp*(T3-T2);

Q=Q_12+Q_23;
disp("heat rejected is:");
disp("kJ",-Q);

ch_entro=m*cp*log(T2/T3)-m*cv*log(T2/T3);
disp("decrease in entropy of air is:");
disp("kJ/K",ch_entro)
```

Scilab code Exa 4.4 4

```
clc;
s1=5.615;//kJ/kg K
t1=311;//C
t2=300;//C
t3=350;//C
s2=7.124+(t1-t2)/(t3-t2)*(7.301-7.124);

T=t1+273;//K
Q=T*(s2-s1);
disp("heat supplied is:");
disp("kJ/kg",Q)

u1=2545;//kJ/kg
u2=2794+(t1-t2)/(t3-t2)*(2875-2794);

W=(u2-u1)-Q
disp("work done by the steam is:");
disp("kJ/kg",-W)
```

Scilab code Exa 4.5 5

```
clc;
R_=8314.5;
m_=28;
R=R_/m_
p1=1.05;//bar
p2=4.2;//bar
s2=R*log(p1)/1000;
s1=R*log(p2)/1000;
disp("change of entropy is:");
disp("kJ/kg K",s2-s1);

T=15+273;
V=0.03;
m=p1*V*10^5/(R*T);
S1=m*s1;
S2=m*s2;
Q=T*(S1-S2);
disp("heat rejected is:");
disp("kJ/kg",Q);

W=-Q;
disp("work done is:");
disp("kJ",W)
```

Scilab code Exa 4.6 6

```
clc;
s1=6.091;//kJ/kg K
s2=s1;
sf=2.138;//kJ/kg K
```

```
sfg2=4.448;
x2=(s2-sf)/sfg2;

uf=762;
ug=2584;
u2=(1-x2)*uf+x2*ug;

h1=3017;
p1=100;//bar
v1=0.02453;//m^3
u1=h1-p1*v1*10^5/10^3;

W=u2-u1;
disp("Work done is;")
disp("kJ",-W)
```

Scilab code Exa 4.7 7

```
clc;
s1=1.7189;
v1=0.0978;//m^3
p1=2.01;//bar
p2=10;//bar
lamda=1.1;

v2=v1*(p1/p2)^(1/lamda);

s_1=1.7564;//kJ/kg K
s_2=1.7847;//kJ/kg K
v_1=0.0228;//m^3
v_2=0.0222;//m^3
v_3=0.0233;//m^3
s2=s_1+[(v_1-v_2)/(v_3-v_2)]*(s_2-s_1)
disp("increase in entropy");
disp("kJ/kg K",s2-s1)
```

Scilab code Exa 4.8 8

```
clc;
p1=6.3;//bar
p2=1.05;//bar
n=1.3;
T1=823;//K
T2=T1/([p1/p2]^([n-1]/n))
R=0.287;
sA_s1=R*log(p1/p2);//sA_s1=sA-s1
cp=1.005;
sA_s2=cp*log(T1/T2);

disp("increase in entropy is:");
disp("kJ/kg",sA_s1-sA_s2)
```

Scilab code Exa 4.9 9

```
clc;
R_=8314.5;
m_=44;
R=R_/m_;

p2=8.3;//bar
V2=0.004;//m^3
m=0.05;
T2=p2*V2*10^5/(m*R);

p2=8.3;//bar
pA=1;//bar
sA_s2=(R/1000)*log(p2/pA);
```

```
cp=0.88;
T2=351;//K
T1=288;//K
sA_s1=cp*log(T2/T1);

dec_ent=m*(sA_s2-sA_s1);
disp("decrease in entropy is:");
disp("kJ/K",dec_ent)
```

Scilab code Exa 4.10 10

```
clc;
x1=0.96;
sf1=1.992;
sfg1=4.717;
s1=sf1+x1*sfg1;

hf1=697;
hfg1=2067;
h1=hf1+x1*hfg1;
h2=h1;

hf2=584;
hfg2=2148;
x2=(h2-hf2)/hfg2;

sf2=1.727;
sfg2=5.214;
s2=sf2+x2*sfg2;

disp("increasi in entropy is:");
disp("kJ/kg K",s2-s1)
```

Scilab code Exa 4.11 11

```
clc;
R=0.287;
ch_ent=R*log(2);//V2=2*V1
disp("increase in entropy is:");
disp("kJ/kg K",ch_ent);
```

Scilab code Exa 4.12 12

```
clc;
T1=703;//K
p1=6.8;//bar
p2=1.013;//bar
gama=1.4;
T2=T1/[(p1/p2)^([gama-1]/gama)];

//from graph:
T2s=423;//K
cp=1.005;
inc_ent=cp*log(T2/T2s);
disp("increasi in entropy is:");
disp("kJ/kg K",-inc_ent)
```

Scilab code Exa 4.13 13

```
clc;
h1=3248;//kJ/kg
h2=2965;//kJ/kg
```

```
h2s=2753+[(7.126-6.929)/(7.172-6.929)]*(2862-2753);

eff=(h1-h2)/(h1-h2s);
disp("isentropic efficiency is:");
disp("%",eff*100);

s1=7.126;//kJ/kg K
s2=7.379;//kJ/kg K
T0=288;//K
loss=h1-h2+T0*(s2-s1);
disp("loss of energy is:");
disp("kJ/kg K",loss);

e=(h1-h2)/loss;
disp("effectiveness is:");
disp("%",e*100);
```

Scilab code Exa 4.14 14

```
clc;
T2=90;//K
T3=40;//K
T1=15;//K
y=(T3-T1)/(T2-T3);

cp=1.005;
h3=40;
h1=15;
h2=90;
T0=288;//K
T3=313;//K
T1=288;//K
T2=363;//K
s3_s1=cp*log(T3/T1);
inc=cp*(h3-h1)-T0*s3_s1;
```

```

s2_s3=cp*log(T2/T3)
loss=0.5*[cp*(h2-h3)-T0*(s2_s3)]
e=inc/loss;
disp("effectiveness is:");
disp("%",e*100);//ans diff due to differance in value of logarithmic values
```

Scilab code Exa 4.15 15

```
clc;
cp=6.3;
h2=70;
h1=15;
T0=283;//K
T1=343;//K
T2=288;//K
T3=1400+273;//K
s2_s1=cp*log(T1/T2);
b2_b1=cp*(h2-h1)-T0*(s2_s1);

loss=cp*(h2-h1)*(1-T0/T3)
eff=b2_b1/loss
disp("effectiveness is:")
disp("%",eff*100)
```

Chapter 5

The Heat Engine Cycle

Scilab code Exa 5.1 1

```
clc;
T2=10+273;//K
T1=2000+273;//K
eta=1-T2/T1;
disp("highest possible efficiency is:");
disp("%",eta*100)
```

Scilab code Exa 5.2 2

```
clc;
T2=15+273;
T1=800+273;
eta=1-(T2/T1);
p4=210;//bar
p2=1;//bar
R=0.218;
sA_s4=R*log(p4/p2);

```

```
cp=1.005;
sA_s2=cp*log(T1/T2);

output=(T1-T2)*(sA_s4-sA_s2);

W41=T1*(sA_s4-sA_s2);
cv=0.718;
W21=cv*(T1-T2);

gross=W41+W21;
disp(W41)
work=output/gross;
disp("work ratio is");
disp(work)
```

Scilab code Exa 5.3 3

```
clc;
p1=1.02;//nar
p2=6.12;//bar
y=1.4
eta=1-[(p1/p2)^[(y-1)/y]]

T1=288;//K
T2=[(p1/p2)^[-(y-1)/y]]*T1;
T3=800+273;//K
T4=T3*[(p1/p2)^[(y-1)/y]];

cp=1.005;
net_output=cp*(T3-T4)-cp*(T2-T1);
gross_output=cp*(T3-T4);

W=net_output/gross_output
disp("Work ratio is:");
disp(W)
```

Scilab code Exa 5.4 4

```
clc;
bore=5;//cm
stroke=7.5;//cm
V=(%pi/4)*5^2*7.5
V0=21.3;
tV=V+V0;

rv=tV/V0;

y=1.4;
eta=1-[rv^(1-y)];
disp("efficiency is:");
disp("%",eta*100)
```

Scilab code Exa 5.5 5

```
clc;
T1=15+273;//K
T3=1100;//K
rv=12;
y=1.4;

T2=T1*rv^(y-1);
T3=1373;
T2=778;
T4=T3/[[rv*(T2/T3)]^(y-1)];

cp=1.005;
Q1=cp*(T3-T2);
```

```
cv=0.718;
Q=cv*(T4-T1);
eta=(Q1-Q)/Q1;
disp("efficiency is: ");
disp("%",eta*100)
```

Scilab code Exa 5.6 6

```
clc;
v1!v2=18;
y=1.4;
T1=293;//K
T2=v1!v2^(y-1)*T1;

p3=69;//bar
p1=1.01;//bar
p2=v1!v2^y*p1
T3=p3*T2/p2

cv=0.718;
cp=1.005;
T4=cv*(T3-T2)/cp+T3;

v5!v4=v1!v2*(T3/T4);
T5=T4/[(v5!v4)^(y-1)];
Q1=2*cv*(T3-T2);

eta=(Q1-[cv*(T5-T1)])/Q1
disp("efficiency is")
disp("%",eta)
```

Scilab code Exa 5.7 7

```
clc;
eta=0.682;
Q=260;//kJ/kg
W=-eta*Q;
R=287;
T1=293;
p1=1.01
v1_v2=(17/18)*(R*T1)/(p1*10^5);
pm=-W*10^3/(v1_v2*10^5);
disp("mean effective pressure is:");
disp("bar",pm)
```

Chapter 6

Mixtures

Scilab code Exa 6.1 1

```
clc;
M_O=23.3/100;//kg
M_N=76.7/100;//kg
M_C=45/100;//kg
R=8.3145;
T=288;//K
V=0.4;//m^3

m_o=32;
m_n=28;
pO=M_O*R*T*10^3/(m_o*V*10^5);
pN=M_N*R*T*10^3/(m_n*V*10^5);
m_c=28;
pC=M_C*R*T*10^3/(m_c*V*10^5);
p=pO+pN+pC;

disp("bar",pO,"partial pressure of Oxygen is:")
disp("bar",pN,"partial pressure of Nitrogen is:")
disp("bar",pC,"partial pressure of Carbon monoxide
   is:")
disp("bar",p,"total pressure is:")
```

Scilab code Exa 6.2 2

```
clc;
R=8.3145;
m_o=31.999;
m_n=28.013;
m_a=39.948;
m_c=44.010;

R_O=R/m_o;
R_N=R/m_n;
R_A=R/m_a;
R_C=R/m_c;

miO=0.2314;
miN=0.7553;
miA=0.0128;
miC=0.0005;

R_=(miO*R_O)+(miN*R_N)+(miA*R_A)+(miC*R_C);

m_=R/R_
disp("specific gas constant of air is:")
disp(R_)
disp("molar mass of gas is:");
disp(m_)
```

Scilab code Exa 6.3 3

```
clc;
miO=0.2314; //kg/kmole
```

```
miN=0.7553;//kg/kmole
miA=0.0128;//kg/kmole
miC=0.0005;//kg/kmole

m_O=31.999;//kg/kmole
m_N=28.013;//kg/kmole
m_A=39.948;//kg/kmole
m_C=44.010;//kg/kmole

niO=miO/m_O;//kmole
niN=miN/m_N;//kmole
niA=miA/m_A;//kmole
niC=miC/m_C;//kmole

n=niO+niN+niA+niC;//kmole

V_O=niO*100/n;
V_N=niN*100/n;
V_A=niA*100/n;
V_C=niC*100/n;

p=1;
piO=V_O*p/100;
piN=V_N*p/100;
piA=V_A*p/100;
piC=V_C*p/100;

disp("analysis of volume of Oxygen, Nitrogen, Argon
    and Carbon dioxide respectively are");
disp(V_C,V_A,V_N,V_O);

disp("partial pressure of Oxygen, Nitrogen, Argon
    and Carbon dioxide respectively are");
disp(piC,piA,piN,piO);
```

Scilab code Exa 6.4 4

```
clc;
VO=0.21;
VN=0.79;
n=3.5;

nO=VO*n;
nN=VN*n
nC=1;

m_O=32;
m_N=28;
m_C=44;

mO=m_O*nO;
mN=m_N*nN;
mC=m_C*nC;

m=mO+mN+mC;
disp("total mass is:");
disp("kg",m);

//percentage of carbon is
mc=12;
P=mc*100/m;
disp("percentage of carbon is:");
disp("%",P)


n=nO+nN+nC;
m_=[nO*m_O/n]+[nN*m_N/n]+[nC*m_C/n]

R_=8.3145;
R=R_/m_;
disp("specific gas constant for the mix is:");
disp("kJ/kg K",R);

```

```
T=288;//K
p=1;//bar
v=R*T*10^3/(p*10^5);
disp("specific volume of the mix at 1 bar and 15 C
    is");
disp("m^3/kg",v)
```

Scilab code Exa 6.5 5

```
clc;
nH=0.5;//kmole
m_O=32;
VH!VO=2;
x=m_O*nH/VH!VO;
disp("mass of oxygen required is:");
disp("kg",x)
nO=x/m_O;
n=nH+nO;
R_=8.3145;
T=288;//K
p=1;//bar
V=n*R_*T*10^3/(p*10^5);
disp("Volume of container is:");
disp("m^3",V);
```

Scilab code Exa 6.6 6

```
clc;
m_H=2;
m_CO=28;
xH=0.8;
xCO=0.2;

```

```
m_=xH*m_H+xCO*m_CO;

x=(xH-0.5)*9;
disp("mass of mixture removed is:");
disp("kg",x)

y=28/7.2*x;
disp("mass of CO added");
disp("kg",y)
```

Scilab code Exa 6.7 7

```
clc;
nC=0.120;//kmol
nO=0.115;//kmol
nN=0.765;//kmol

m_C=44;//kg/kmol
m_O=32;//kg/kmol
m_N=28;//kg/kmol

miC=m_C*nC;//kg
miO=m_O*nO;//kg
miN=m_N*nN;//kg

m=miC+miO+miN;

cpC=1.271;//kJ/kgK
cpO=1.110;//kJ/kgK
cpN=1.196;//kJ/kgK

cp=cpC*(miC/m)+cpO*(miO/m)+cpN*(miN/m);

R_=8.3145;//kJ/kg K

```

```
R=(miC/m)*(R_/m_C)+(miO/m)*(R_/m_O)+(miN/m)*(R_/m_N)
    ;

cv=cp-R;

T1=1000+273;
v1!v2=1/7;
n=1.25;
T2=T1*(v1!v2)^(n-1);

W=R*(T2-T1)/(n-1);
disp("Work done by th gas mixture is:");
disp("kJ/kg",-W,R,T2);

disp("heat supplied is:");
Q=[cv*(T2-T1)]-W;
disp("kJ/kg",Q);
```

Scilab code Exa 6.8 8

```
clc;
R=0.274;
T1=1000+273;
v1!v2=1/7;
n=1.25;
T2=T1*(v1!v2)^(n-1);
sA_s1=R*log(1/v1!v2);

cv=0.925;
sA_s2=cv*log(T1/T2);
disp("change of entropy of mixture is:");
disp("kJ/kg K",sA_s1-sA_s2);
```

Scilab code Exa 6.9 9

```
clc;
cp_CO=29.27;//kJ/kmol K
cp_H=28.89;//kJ/kmol K
cp_CH4=35.80;//kJ/kmol K
cp_CO2=37.22;//kJ/kmol K
cp_N=29.14;//kJ/kmol K

niCO=0.29;
niH=0.12;
niCH4=0.03;
niCO2=0.04;
niN=0.52;

cp_=cp_CO*niCO+cp_H*niH+cp_CH4*niCH4+cp_CO2*niCO2+
    cp_N*niN;

R_=8.3145;
cv_=cp_-R_;

m_CO=28;
m_H=2;
m_CH4=16;
m_CO2=44;
m_N=28;

m_=niCO*m_CO+niH*m_H+niCH4*m_CH4+niCO2*m_CO2+niN*m_N
    ;

cp=cp_/m_;
cv=cv_/m_;

disp("the values of cp_,cv_,cp and cv respectively
    are:");
disp("kJ/kg K",cv,"kJ/kg K",cp,"kJ/kg K",cv_,"kJ/kg
    K",cp_)
```

Scilab code Exa 6.10 10

```
clc;
p0=7;//bar
V0=1.5;//m^3
R_=8.3145;
T0=313;//K
n0=p0*V0*10^5/(R_*T0*10^3);

pC=1;//bar
VC=3;//m^3
TC=288;//K
nC=pC*VC*10^5/(R_*TC*10^3);

cv0=21.07;
cvC=20.86;
U1=n0*cv0*T0+nC*cvC*TC;
U2_T=n0*cv0+nC*cvC;

T=U1/U2_T;

p=(n0+nC)*R_*T*10^3/(V0+VC)/10^5;
disp("final temperature and pressure of mixture is:"
    );
disp("bar",p,"K",T)

//part(II)
VA=4.5;//m^3
SA_S1_0=n0*R_*log(VA/V0);
SA_S2_0=n0*cv0*log(T0/T);
q1=SA_S1_0-SA_S2_0;

SA_S1_C=nC*R_*log(VA/VC);
SA_S2_C=nC*cvC*log(TC/T);
```

```
q2=SA_S1_C-SA_S2_C;

disp("change in entropy is:");
disp("kJ/k",q1+q2);
```

Scilab code Exa 6.11 11

```
clc;
V=0.3;//m^3
vg=4.133;//m^3/kg
m=V/vg;
disp("mass of water injected:");
disp("kg",m)

//part B
pa=0.7;//bar
pg=0.3855;//bar
v=0.001026;
ms=(V-[pa*v])/[vg-v];

mw=pa-ms;
V_d=ms*vg
pa2=pa*V/V_d;
disp("total pressure is:");
disp("bar",pa2+pg);
```

Scilab code Exa 6.12 12

```
clc;
ni!n=0.15;
p=1.4;//bar
x=ni!n*p;
```

```
//saturation temperature corresponding to 0.21 bar
   is 61.15 C
t=61.15;//C
disp("Temperature required is:");
disp("C",t)
```

Scilab code Exa 6.13 13

```
clc;
ma=0.3/1000;//kg
Ra=0.287;
T=311;//K
V=21.63//m^3

p=ma*Ra*T*10^3/(V*10^5);

T2=36+273;//K
p2=0.0594;//bar
vg=23.97;//m^3/kg
pt=0.6624;//bar
pa=pt-p2;
mf=20000*0.3/1000;

Vr=mf*Ra*T2*10^3/(pa*10^5);

ms=Vr/vg

T3=300;//K
P3=0.0306;
v=mf*(Ra)*T3*10^3/(P3*10^5)

vg1=38.81;
steam=v/vg1;
disp("steam removed is:");
disp("kg/H",steam)
```

Scilab code Exa 6.14 14

```
clc;
capacity_ac=778;//m^3/h
capacity=168.9;//m^3/h

red=(capacity_ac-capacity)*100/capacity_ac
disp("percentage reduction in air pump is:");
disp("%",red);

ms2=4.35;//kg/h
ms1=20000;//kg/h
ma1=6;//kg/h
ma2=ma1;
mc=20000;//apprx

hs2=2550.3;
hc=150.7;
hs1=2570.1;

cp=1.005;
T1=38;
T2=27;
ha1_ha2=cp*(T1-T2);

Q=ms2*hs2+{ma1*ha1_ha2}+mc*hc-ms1*hs1;

//mass of cooling water required
disp("mass of cooling water required");
t=5.5
M=-Q/(t*4.182);
disp("kg/h",M)
```

Chapter 7

Combustion

Scilab code Exa 7.1 1

```
clc;
m_C=12;
m_O2=32;
x_C=0.9;
O_req_CO2=x_C*([m_O2*1]/[m_C*1]);
CO2_prod=x_C*([m_C*1]+[m_O2*1])/[m_C*1];
//HYDROGEN
m_H2=2;
x_H=0.03;

O_req_H2O=x_H*[m_O2/2/2];
steam_prod=x_H*{0.5*[(m_H2)+(m_O2)/2]};
//SULPHUR
m_S=32;
x_S=0.005;
O_req_SO2=x_S*(m_O2/32);
SO2_prod=2*x_S;

O_req=O_req_CO2+O_req_H2O+O_req_SO2;
%O=23.3;
A=O_req*100/%O;
```

```
disp("A/F ratio is:");
disp(A);

//part (ii)
actual_A=A*(1+0.2);
%N=076.7;
m_N2=28;
N_supp=actual_A*%N/100;
O_supp=actual_A*%O/100;
x_N=0.01;
N2=N_supp+x_N;
O2=O_supp-O_req;
disp("actual A/F ratio is");
disp(actual_A);

m_CO2=m_C+m_O2;
m_H2O=m_H2+0.5*m_O2;
m_SO2=m_S+m_O2;

ni_CO2=CO2_prod/m_CO2;
ni_H2O=steam_prod/m_H2O;
ni_SO2=SO2_prod/m_SO2;
ni_O2=O2/m_O2;
ni_N2=N2/m_N2;

n_wet=ni_CO2+ni_H2O+ni_SO2+ni_O2+ni_N2;
n_dry=ni_CO2+ni_SO2+ni_O2+ni_N2;
disp(O_supp)
CO2_wet=ni_CO2/n_wet;
H2O_wet=ni_H2O/n_wet;
SO2_wet=ni_SO2/n_wet;
O2_wet=ni_O2/n_wet;
N2_wet=ni_N2/n_wet;

disp("wet analysis of CO2,H2O,SO2,O2,N2");
disp(N2_wet*100,O2_wet*100,SO2_wet*100,H2O_wet*100,
    CO2_wet*100);
```

Scilab code Exa 7.2 2

```
clc;
//part I
%H2=0.494;
%CO=0.18;
%CH4=0.2;
%C4H4=0.02;
%O2=0.004;
%N2=0.062;
%CO2=0.04;

O_H2=%H2/2;
O_CO=%CO/2;
O_CH4=%CH4*2;
O_C4H4=%C4H4*6;
O_O2=-%O2*1;

C_CO=%CO;
C_CH4=%CH4;
C_C4H8=4*%C4H4;
C_CO2=%CO2;

H_H2=%H2;
H_CH4=2*%CH4;
H_C4H8=4*%C4H4;

O_Tot=O_C4H4+O_CH4+O_CO+O_H2+O_O2;
C_Tot=C_CO+C_CH4+C_C4H8+C_CO2;
H_Tot=H_H2+H_CH4+H_C4H8;

AF=O_Tot/0.21;
disp(AF,"stoichiometric A/F ratio is:")

```

```
//partII

actual_AF=AF+0.2*AF;
Ass_N2=0.79*actual_AF;
Exs_O2=(0.21*actual_AF)-O_Tot;
N2_Tot=Ass_N2+%N2;

Tot_wet=H_Tot+C_Tot+Exs_O2+N2_Tot;
Tot_dry=C_Tot+Exs_O2+N2_Tot;

C_dry=(C_Tot)/Tot_dry*100;
O_dry=(Exs_O2)/Tot_dry*100;
N_dry=(N2_Tot)/Tot_dry*100;

C_wet=(C_Tot)/Tot_wet*100;
O_wet=(Exs_O2)/Tot_wet*100;
N_wet=(N2_Tot)/Tot_wet*100;
H_wet=(H_Tot)/Tot_wet*100;

disp("Analysis by volume of the wet product of CO2, H2O,O2,N2 respectively is:");
disp(N_wet,O_wet,H_wet,C_wet)

disp("Analysis by volume of the dry product of CO2, O2,N2 respectively is:");
disp(N_dry,O_dry,C_dry)
```

Scilab code Exa 7.3 3

```
clc;
m_C2H6O=46;
m_O2=3*32;
O2_req=m_O2/m_C2H6O;
s_AF=O2_req/0.233;
disp(s_AF,"stoichiometric A/F ratio is:")
```

```

//part II
disp("")
AF=s_AF/0.9;
disp(AF,"actual A/F ratio is:")
mC=2;
mH=3;
mO=0.333;
mN=12.540;
Tas=mC+mO+mH+mN;
disp(mN/Tas*100,mO/Tas*100,mH/Tas*100,mC/Tas*100,"wet analysis of CO2,H2O,O2,N2");

Tad=mC+mO+mN;
disp(mN/Tas*100,mO/Tas*100,mC/Tas*100,"dry analysis of CO2,O2,N2");

//part III
disp("")
a_AF=s_AF/1.2;
disp(a_AF,"actual A/F ratio is:")

mCO2=1;
mCO=1;
mH2=3;
mN2=9.405;
taw=mCO2+mCO+mH2+mN2;

disp(mN2/taw*100,mH2/taw*100,mCO/taw*100,mCO2/taw*100,"wet analysis of CO2,H2O,O2,N2");

tad=mCO2+mCO+mN2;
disp(mN2/tad*100,mCO/tad*100,mCO2/tad*100,"dry analysis of CO2,H2O,O2,N2");
```

Scilab code Exa 7.4 4

```
clc;
mC=1;
mO=3;
mN=(3*79/21);
Tar=mC+mO+mN;

p1=1.013*10^5;
R=8.3145*10^3;
T=338;
V=Tar*R*T/p1;

Vr=V/[(2*12)+6+16];
disp(Vr,"Volume of reactants per kilogram of fuel:")
   ;

//part II
mCO2=2;
mH2O=3;
mN2=(3*79/21);
Tap=mCO2+mH2O+mN2;

T=393;
p=10^5;

V=Tap*R*T/p1;
Vr=V/[(2*12)+6+16];

disp(Vr,"Volume of products per kg of fuel is:");
```

Scilab code Exa 7.5 5

```
clc;
mCO2=2;
```

```
mH2O=3;
mN2=(3*79/21);
m_C2H6O=46;
Tadp=mCO2+mN2;
Tap=mCO2+mN2+mH2O;

nl=0.01704;
n=1;

n1=nl*Tadp/(1-nl)
m=[(mH2O-n1)*18/m_C2H6O]
disp(m)
```

Scilab code Exa 7.6 6

```
clc;
a=0.8/12;
b=0.12/2;
x=a+b/2;

s_AF=32*x/0.233;
disp(s_AF,"stoichiometric A/F ratio is:");

Twp=a+b+3.76*x;
C=a/Twp*100;
H=b/Twp*100;
N=.365/Twp*100;

disp(N,H,C,"wet analysis of C,H, and N respectively
   is:")
```

Scilab code Exa 7.7 7

```
clc;
a=1;
c={6.31-2-(2*1.95)}/2
d=0.03+(0.79*30)
tds=a+c+d;

C=a/tds*100
O=c/tds*100
N=d/tds*100

disp(N,O,C,"analysis by volume is:");
```

Scilab code Exa 7.8 8

```
clc;
B=0.9/12/0.15;
b=0.1/2;
A=15.14;
a=0.02
AF=A;
disp(AF,"A/F ratio is:");

%C=.15;
%O=.20;
%N=.65;
twp=B*%C+B*%O+B*%N+b;

C=B*%C/twp*100;
O=B*%O/twp*100;
N=B*%N/twp*100;
H=b/twp*100;

disp(H,N,O,C,"wet volumetric analysis is as follows:
  ");
```

Scilab code Exa 7.9 9

```
clc;
x=0.8805;
B=3.41*(1-x);
A=27.927*B;
AF=A;
disp(AF,"A/F ratio is:");
```

Scilab code Exa 7.10 10

```
clc;
b=0.228;
a=1-b;
c=[1+(2*0.455)-b-2*a]/2

n2=a+b+c+1.709;

p1=8.28;
T2=555;

n1=1+0.455+1.709;
T1=2968;
p2=p1*(n2/n1)*(T1/T2);
p=1;

K=a/b*[n2*p/(c*p2)]^0.5;
disp(log(K),"log(K) is:");
disp("2968","from tables it is proved that
   temperatur is:")
```

Scilab code Exa 7.12 12

```
clc;
mH2O=3*18;
q=2441.8;
h0=-3301397+(mH2O*q)
disp(h0," h0 for H2O in the vapour phase:")
```

Scilab code Exa 7.13 13

```
clc;
h0=3169540
nR=1+7.5;
nP=6+3;
R=8.3145;
T=298;
U0=-(h0)-{(nP-nR)*R*T};
c=(6*12)+(6*1);
u0=U0/c
disp(u0,"specific internal energy of reaction for
    the combustion of benzene vapour is:")
```

Scilab code Exa 7.14 14

```
clc;
H0=282990;
HRo=(1*1018)+(0.5*1036);
HRr=(1*86115)+(0.5*90144);
HPo=1*1368;
```

```
HPr=1*140440;

HT=H0+(HRr-HRo)-(HPr-HPo);
disp(HT," h at 2800 K is:")
```

Scilab code Exa 7.15 15

```
clc;
a=0.909;
b=0.091;
nR=1+0.5;
nP=1;
H0=-282990;
R=8.3145;
T0=298;

U0=H0-(nP-nR)*R*T0;

UR0=-7844;
UR1=9487;
UP0=-6716;
UP2=(a*281751)-(UR0-UR1)+UP0

UP2_=(a*138720)+(b*74391)+(1.709*73555);

disp("which compares with the actual,hence actual
   temperature of the products is slightly greater
   than 3200",UP2_,"and UP2 at T=3200",UP2,"actual
   UP2 is")
```

Scilab code Exa 7.16 16

```
clc;
```

```
a=0.8;
T2=3000;
n2!p2=212.08/T2;
K=a/(1-a)*[n2!p2/(0.455-0.5*a)]^0.5;
disp("by sucha a method the value of T2 is found to
   be 2949 to the nerest degree")
```

Scilab code Exa 7.17 17

```
clc;
hR=-281102;
hP=2*-393520+3*-241830;
h=-hR+hP
disp(h,"molar enthalpY is")
```

Scilab code Exa 7.18 18

```
clc;
mw1=2*0.965*18;
mw2=3*0.005*18;
mw=mw1+mw2;

R=8314.5
T=288;
p=1.013*10^5;
v=R*T/p

mc=mw/v;

hfg=2441.8;
Qgt=38700;
Qn=Qgt-mc*hfg;

```

```
hs=3421;
hf=419.1;
Q=hs-hf;
s_o=31.6;
f_c=2.85;
nB=Q*s_o/(f_c*Qn);

disp(nB*100,"boiler efficiency is:");

g_o=25000;
n=g_o/(f_c*Qn)
disp(n*100,"overall thermal efficiency is:")
```

Scilab code Exa 7.19 19

```
clc;
n=5;
t0=25.740
tn=27.880
v=-[(t0-25.730)/5];
v1=(tn-27.870)/5;
t=25.735;
t1=27.875;
Et=110.9880;

corc=-5*v1+[(v1-v)/(t1-t)]*[Et+26.81-5*t];
temp_rise=tn-t0;
c_temp_rise=temp_rise+corc;

q=c_temp_rise*2500*4.187*10^-3;
Q=q/(.825*10^-3);
disp("kJ/kg",Q,"calorific value of fuel is:");
```

Scilab code Exa 7.20 20

```
clc;
mc=0.144*9;
Qgt=46900;
ufg=2304.4;

Qn=Qgt-mc*ufg;
disp("kJ/kg",Qn,"NCV is:")
```

Scilab code Exa 7.21 21

```
clc;
m_EtOH=46;
aof=1/m_EtOH;
m_a=28.96;
AF=8.957;
aoa=AF/m_a;

Total=aof+aoa;

R=8314.5;
T=288;
p=1.013*10^5;
V=Total*R*T/p;

NCVf=27.8;
NCVm=NCVf/V;

disp("MJ/m^3",NCVm,"calorific value of the
    combustion mixture is:");
```

Scilab code Exa 7.22 22

```
clc;
m_EtOH=46;
aof=1/m_EtOH;
m_a=28.96;
AF=8.957;
aoa=AF/m_a;

Total=aof+aoa;
p0=aof/Total;

//from table
t1=20;
t2=30;
p1=0.0584;
p2=0.1049;

t=t1+[(p0-p1)/(p2-p1)]*(t2-t1);
disp("C",t,"minimum temperature of the mix is:");
```

Chapter 8

Steam Cycles

Scilab code Exa 8.1 1

```
clc;
T1=526.2;
T2=299.7;
nC=(T1-T2)/T1;
disp(nC,"carnot cycle efficiency is:")
Q=1698;
W=nC*Q;

h1=2800;
s1=6.049;
s2=s1;
sf2=0.391;
sfg2=8.13;
x2=(s2-sf2)/sfg2;

hf2=112;
hfg2=2438;
h2=hf2+(x2*hfg2);

W12=h1-h2;

```

```
Wr=W/W12;
disp(Wr,"work ratio is:")
ssc=1/W;
disp("kg/k W h",ssc,"ssc is:");

//part III
disp("")
h3=112;
vf=0.001
p4=42;
p3=0.035;

PW=vf*(p4-p3)*(10^5/10^3);
nR=[{(h1-h2)-(PW)}/{(h1-h3)-(PW)}]
disp(nR,"rankine cycle efficiency is:");

Wr=(W12-PW)/(W12)
disp(Wr,"Work ratio is");

ssc=1/(W12-PW)
disp("kg/k W h",ssc,"Work ratio is:");

//partIII
disp("");
W12_=0.8*W12;
Ceff=[(h1-h2)-PW]/[(h1-h3)-PW];
disp(Ceff,"rankine cycle of isentropic efficiency is
    :")

Wr=[W12_-PW]/W12_
disp(Wr,"Work ratio is:");

ssc=1/[(h1-h2)-PW]
disp("kg/kW s",ssc,"ssc is:")
```

Scilab code Exa 8.2 2

```
clc;
h1=3442.6;
s1=7.066;
s2=s1;
sf2=0.391;
sfg2=8.13;
x2=(s2-sf2)/sfg2

hf2=112;
hfg2=2438;
h2=hf2+x2*hfg2;

h3=112;
W12_=h1-h2;

Q=h1-h3;

Ceff=(h1-h2)/(h1-h3);
disp(Ceff,"cycle efficiency is:");

ssc=1/(h1-h2);
disp("kg/kW h",ssc,"specific steam consumption is:")
    ;

disp("cycle efficiency has increased due to
    superheating and the improvement in specific
    steam consumption is even more marked:")
```

Scilab code Exa 8.3 3

```
clc;
h1=3442.6;
h2=2713;
```

```
h6=3487;
h7=2535;
h3=112;

TW=(h1-h2)+(h6-h7);

Q=(h1-h3)+(h6-h2);

Ceff=TW/Q;
disp(Ceff,"cycle efficiency is:");

ssc=1/TW;
disp("kg/kW h",ssc,"specific steam consuption is:")
```

Scilab code Exa 8.4 4

```
clc;
t1=253.2;
t2=26.7;
t6=(t1+t2)/2;

h7=584;
h3=112;
s1=6.049;
s6=s1;
s2=s1;

x6=(s1-1.727)/5.214;
x2=(s1-0.391)/8.130;

hf6=584;
hfg6=2148;
h6=hf6+x6*hfg6;

hf2=112;
```

```
hfg2=2438;
h2=hf2+x2*hfg2;

y=(h7-h3)/(h6-h3);

h1=2800;
Q=(h1-h7);

Tot=(h1-h6)+[(1-y)*(h6-h2)];

Ceff=Tot/Q;
disp("%",Ceff*100,"cycle efficiency is:");

ssc=1/Tot
disp("kg/kJ",ssc,"ssc is:")
```

Chapter 9

Gas Turbine Cycles

Scilab code Exa 9.1 1

```
clc;
T1=288;
p2!p1=10;
y=1.4;
T2s=T1*[(p2!p1)^{(y-1)/y}];

nc=0.82;
T2=(T2s-T1)/nc+T1;

T3=973;
y2=1.333;
T4s=T3/[(p2!p1)^{(y2-1)/y2}]

nt=0.85;
T4=T3-(T3-T4s)*nt

cp=1.005;
cp2=1.11;
Wi=cp*(T2-T1);
Wo=cp2*(T3-T4);

```

```
N=(Wo-Wi);
P=(N*15)
disp("W",P,"powar output is");
```

Scilab code Exa 9.2 2

```
clc;

T1=288;
p2!p1=10;
y=1.4;
T2s=T1*[(p2!p1)^{(y-1)/y}];

nc=0.82;
T2=(T2s-T1)/nc+T1;

T3=973;
y2=1.333;
T4s=T3/[(p2!p1)^{(y2-1)/y2}]

nt=0.85;
T4=T3-(T3-T4s)*nt

cp=1.005;
cp2=1.11;
Wi=cp*(T2-T1);
Wo=cp2*(T3-T4);

N=(Wo-Wi);

Q=cp2*(T3-T2);
Ceff=N/Q
disp("$",Ceff*100,"cycle efficiency is:");

Wratio=N/Wo;
```

```
disp(Wratio*100,"Work ratio is:");
```

Scilab code Exa 9.3 3

```
clc;
p2!p1=8;
T1=290;
y=1.4;
T2s=T1*({p2!p1}^[(y-1)/y]);
nc=0.8;
T2=[(T2s-T1)/nc]+T1;

cps=1.005;
T3=923;
Wi=cps*(T2-T1);
Wo=Wi;
cps2=1.15;
T4=T3-[Wo/cps2]

nt=0.85;
T4s=T3-[(T3-T4)/nt];

p3=8*1.01;
y2=1.333;
p4=p3/[(T3/T4s)^{y2/(y2-1)}];
disp("bar",p4,"pressure at entry of the LP.");
disp("K",T4,"temperature at the entry of LP.");

p4!p5=p2!p1*(p4/p3);
T5s=T4/[(p4!p5)^{(y2-1)/y2}];

nT=0.83;
T5=T4-[nT*(T4-T5s)]
WoLP=cps2*(T4-T5);

```

```
N=WoLP*1;
Wr=WoLP/(WoLP+Wo);
disp("kW",Wr,"Work ratio is :");

Q=cps2*(T3-T2);
disp("kJ/kg",Q,"Heat supplied is:");

Ceff=N/Q;
disp("%",Ceff*100,"cycle efficiency is:");
```

Scilab code Exa 9.4 4

```
clc;
y=1.4;
p2!p1=3;
T1=288;
T2s=T1*[(p2!p1)^({y-1}/y)];

nc=0.8;
T2=T1+[T2s-T1]/nc

cps=1.005;
Wi=cps*(T2-T1);
Wo=2*(Wi)/0.98;

T6=923;
cps2=1.15;
T7=T6-Wo/cps2
nT=0.85;
T7s=T6-[(T6-T7)/nT]
y2=1.333;
p8!p9=[p2!p1^2]/[(T6/T7s)^{y2/(y2-1)}];

T8=T6;
T9s=T8/[(p8!p9)^({y2-1}/y2)];
```

```
T9=T8-nT*(T8-T9s)
N=cps2*(T8-T9)*0.98;

Tr=0.75;
T4=420.5;
T5=T4+Tr*(T9-T4)

Q=cps2*([T6-T5]+[T8-T7]);
Ceff=N/Q;
disp(Ceff,"cycle efficiency is:");

//part II
GWo=Wo+N/0.98;
Wr=N/GWo;
disp(Wr,"work ratio is:")

//part III
m=5000/N;
disp("kg/s",m,"rate of flow of air is:")
```

Scilab code Exa 9.5 5

```
clc;
T1=288;
T2s=T1*[3^0.286];
T2=420.5
T4=T2;
p6=8.14;
p6!p7=4.19;
p7=p6/(p6!p7);
p8=(p7-0.2)
p1=1.01
p10=p1
p9=0.05+p10
```

```
y2=1.333;
T8=923;
T9s=T8/[(p8/p9)^({y2-1}/y2)];
T9=T8-[(T8-T9s)*0.85];
cps2=1.15;
N=cps2*(T8-T9);
T5=728.8;
T6=T8;
T7=686.5;
Q=cps2*(T6-T5+T8-T7)
disp("kJ/kg",Q,"Heat supplied is")

Ceff=105.2/Q;
disp("%",Ceff*100,"cycle efficiency is")
GW=(105.2/0.98)+277;

Wr=105.2/GW
disp(Wr,"work ratio is:")
```

Chapter 10

Nozzle and Jet Propulsion

Scilab code Exa 10.1 1

```
clc;
y=1.4;
p1=8.6;
pc=p1*[(2/(y+1))^{y/(y-1)}];

T1=190+273;
Tc=T1*[2/(y+1)];
R=287;
vc=R*Tc/(10^5*pc);
Cc=(y*R*Tc)^0.5;

m=4.5;
A=m*vc/Cc;
disp("mm^3",A*10^6,"Area of troat is:");

p2=1.03;
T1=463;
T2=T1/([p1/[p2]]^([y-1]/y));

v2=R*T2/(10^5*p2);
cp=1.005
```

```
C2=[2*cp*10^3*(T1-T2)]^0.5;
A2=m*v2/C2
disp("mm^3",A2*10^6,"Exit area is:");
```

Scilab code Exa 10.2 2

```
clc;
R_=8314.5;
R=R_/4;
cp=10^3*5.19;
y=1/[1-(R/cp)];
p1=6.9;
pc=([2/(y+1)]^[y/(y-1)])*p1;

T1=93+273;
p2=3.6;
T2=T1/[(p1/p2)^([y-1]/y)];

C2=[2*cp*(T1-T2)]^0.5;
v2=R*T2/(10^5*p2);

A2=1;
m=A2*C2/v2;
disp("kg/s",m,"mass flow per square meter of exit
   area:");

//partII
m_=30;
R=R_/m_;
cp=1880;
y=1/[1-(R/cp)]

p2=3.93;
T2=337;
pc=p1*[2/(y+1)]^[(y/(y-1))];
```

```
Tc=T1*[2/(y+1)];
Cc=[y*R*Tc]^0.5;
v2=R*T2/(10^5*p2);

m=A2*Cc/v2
disp("kg/s",m,"mass flow per square meter of exit
   area is:");
```

Scilab code Exa 10.3 3

```
clc;
p1=3.5;
y=1.333;
pc=p1*[2/(y+1)]^[(y/(y-1))];

T1=425+273;
Tc=T1*[2/(y+1)];
T2=Tc;
cp=1.11*10^3;
Cc=[2*cp*(T1-T2)]^0.5;
C2=Cc;
R=cp*(y-1)/y;
vc=R*Tc/10^5/pc;

m=18/.99;
Ac=m*vc/Cc
disp("m^2",Ac,"throat area is:");
T1=698;
p1=3.5;
p2=0.97;
T2s=T1/[(p1/p2)^{(y-1)/y}];
Neff=0.94;
T2=T1-Neff*(T1-T2s);
v2=R*T2/10^5/p2;
C2=(2*cp*(T1-T2))^0.5;
```

```
m2=18;
A2=m2*v2/C2;
disp("m^2",A2,"exit area is :");
```

Scilab code Exa 10.4 4

```
clc;
y=1.135;
p1=10;
pc=p1*[2/(y+1)]^[(y/(y-1))];
h1=2778;
hc=2675;
xc=0.962;
vg=0.328;
vc=xc*vg;
Cc=(2*[h1-hc]*10^3)^0.5;
A_m=vc/Cc*10^6;
disp(A_m);
```

Scilab code Exa 10.5 5

```
clc;
h1=2846;
h2=2682;
x2=0.98;
vg=0.6057;
v2=x2*vg;
C2=[2*(h1-h2)*10^3]^0.5;
m=0.1;
A2=m*v2*10^6/C2;
disp("mm^2",A2,"Exit area is:");

//part II
```

```
p1=7;
p2=3;
k=1.3;
v1=0.3001;
vr=v1*[(p1/p2)^(1/k)];
y=1.3;
Cr=[2*(y*10^5)/(y-1)*{(p1*v1)-(p2*vr)}]^0.5;
A2=m*vr*10^6/Cr;
disp("mm^2",A2,"Exit area in supersaurated case is:"
    )
```

Scilab code Exa 10.6 6

```
clc;
KE=1/2*(800*1000/3600)^2/1000;

T0=-50+273;
cp=1.005;
T0_=T0+[24.7/cp];

Ieff=0.9;
T0_s=Ieff*(T0_-T0)+T0;

y=1.4;
pa=0.24;
p0_=[(T0_s/T0)^[y/(y-1)]]*pa;
p0_2!p0_=10;
T0_2s=T0_*[p0_2!p0_^([y-1]/y)];

T0_2=T0_+(T0_2s-T0_)/Ieff;

p0_2=10*p0_;
p0_3=p0_2-(0.14);

T0_3=820+273;
```

```
meff=0.98;
cp2=1.15;
T0_4=T0_3-[cp*(T0_2-T0_)/(cp2*meff)];
T0_4s=T0_3-[cp*(T0_2-T0_)/(cp2*meff)]/0.92;
y2=1.333;
p0_4=3.24/[(T0_3/T0_4s)^{(y2/(y2-1))}]

pc=p0_4*([2/(y2+1)]^{y2/(y2-1)});
T0_5=[2/(y2+1)]*T0_4;
T0_5s=T0_4-{(T0_4-T0_5)/0.92};

p5=p0_4/[(T0_4/T0_5s)^(y2/{y2-1})];

R=cp2*(y2-1)/y2;
v5=R*T0_5*1000/10^5/p5;

T5=741.3//K
Cj=(y2*R*1000*T5)^0.5;

A=0.08;
m=A*Cj/v5;
Cg=222.2;
mt=m*(Cj-Cg)
pt=(p5-pa)*A*10^5;
Tt=pt+mt;

Q=m*cp2*(T0_3-T0_2)

C=43300;

mf=Q/meff/C;

SFC=mf*10^3/6453
disp("kg/kNs",SFC,"specific fuel consumption is")
```

Scilab code Exa 10.7 7

```
clc;
v=650*10^3/3600;
KE=(1/2*v^2);
T0=-18+273;
cp=1.005;
Ieff=0.9;
T01=KE/10^3/cp+T0;
T01s=T0+Ieff*(T01-T0)

p02!p01=9;
y=1.4;
T02s=T01*(p02!p01)^[(y-1)/y];

Ieff2=0.89;
T02=T01+(T02s-T01)/Ieff2

W=cp*(T02-T01);
p01!p0=1.215;
p03!p4=p02!p01*p01!p0;
T03=1123;
y2=1.333;
T4=T03/[(p03!p4)^{(y2-1)/y2}];
C4=180.5;
cps=1.15*10^3;
T04=T4+C4^2/(2*cps);
Ieff3=0.93;
Wo=cps*(T03-T04)*Ieff3/1000
Ieff4=0.98;
NW=(Wo-W)*Ieff4;
Q=cps*(T03-T02)/1000
Teff=NW/Q
disp("%",Teff*100,"Thermal efficiency");
```

Chapter 11

Rotodynamic Machinery

Scilab code Exa 11.1 1

```
clc;
Cai=900;
Cb=300;
alpha=20*%pi/180;
Cri=(Cai^2+Cb^2-2*Cb*Cai*cos(alpha))^0.5;
b=asin(Cai*sin(alpha)/Cri);
Beta=180*b/%pi
disp("the blade inlet angle is:");
disp("degree",Beta)

//part II
k=0.7;
Cre=k*Cri
AD=Cri*cos(b);
AE=Cre*cos(b);

Cw=AD+AE;
disp("driving force on wheel is:");
m=1;
Df=m*Cw
disp("N per kg/s",Df);
```

```
//part III
Cfi=Cri*sin(b);
Cfe=Cre*sin(b);
Cf=Cfi-Cfe;
At=m*Cf;
disp("axial thrust is:");
disp("N per kg/s",At)

//part IV
Dp=Cb*Cw;
disp("diagram power per unit mass flow rate:");
disp("kW",Dp/1000);

//part V
De=Cb*Cw/(Cai^2);
disp("Diagram efficiency is");
disp("%",De*100);
```

Scilab code Exa 11.2 2

```
clc;
k=0.9;
Cri1=486;//m/s
Cri2=187.5;//m/s
Caei=327;//m/s
Cre1=k*Cri1;
Cre2=k*Cri2;
Cai2=k*Caei;
//from velocity diagram;
disp("inlet blade angle firls row of moving blades")
;
Bi1=20;
disp("degree",Bi1)
```

```
disp("inlet blade angle fixed blades");
alpha=20;
disp("degree",alpha)

disp("inlet blade angle second row of moving blades");
Bi2=34.5;
disp("degree",Bi2);

//part II
m=1;
Cw1=874;
Cw2=292.5;
disp("N",m*Cw1,"driving force on first row:");
disp("N",m*Cw2,"driving force on second row:");

Cfi1=167;
Cfe1=135;
Cfi2=106;
Cfe2=97;
At1=m*(Cfi1-Cfe1);
At2=m*(Cfi2-Cfe2);
disp("N per kg/s",(At1+At2),"Total axial thrust:");

//part III
T_df=Cw1+Cw2
disp("N per kg/s",T_df,"total driving force");
bv=120
P=T_df*bv/10^3;
Cai1=600;
E=m*Cai1^2/(2*10^3);
De=P/E;
disp("%",De*100,"diagramefficiency is");

//partIV
alpha_i=16*%pi/180;
M=cos(alpha_i)^2;
```

```
disp("%",M*100,"Maximum diagram efficienty is:");
```

Scilab code Exa 11.3 3

```
clc;
Cai=600;
alpha_i=16*%pi/180;
l=25/1000;
m=5;
vi=0.375;
n=m*vi/(Cai*sin(alpha_i)*l);
disp("m",n,"length of nozzle arc is:");

//part II
p=0.025;
Beta_1=18*%pi/180;
Cre=437;
t=0.0005;
l1=m*vi*p/n/(p*sin(Beta_1)-t)/Cre;
bhm=l1;

Beta_2=21*%pi/180;
Crf=294;
lf=m*vi*p/[n*(p*sin(Beta_2)-t)*Crf];
bhf=lf

Beta_3=35*%pi/180;
Crf2=169;
l2=m*vi*p/n/(p*sin(Beta_3)-t)/Crf2;

disp("Blade height at exit of first row, fixed and
    second row is respectively");
disp("mm",l2*1000,"mm",bhf*1000,"mm",bhm*1000);
```

Scilab code Exa 11.4 4

```
clc;
Cai=90;
alpha=20*%pi/180;
Cf=Cai*sin(alpha)

Cb=4*Cf/3;

v=0.6686;//m^3/kg
m=9000/3600;
A=m*v/Cf
h=0.04;
r=A/(2*%pi*h)
N=Cb/(A/h)
disp("rev/s",N,"Wheel speed is:")

//partII
Cw=2*Cai*cos(alpha)-Cb;
DP=m*Cb*Cw;
disp("kW",DP/1000,"diagram powar is:");

//part III
R=Cb*Cw
Cri=[(Cai^2)+(Cb^2)-(2*Cai*Cb*cos(alpha))]^0.5
Ei=Cai^2-(Cri^2/2)
DE=R/Ei
disp("%",DE*100,"diagram efficiency is:");

//part IV
Ed=(Cai^2-Cri^2)/2;
Td=2*Ed;
disp("kJ/kg",Td/1000,"total enthalpy drop per stage:
   ")
```

Scilab code Exa 11.5 5

```
clc;
Cw=115; //m/s
Cb=200; //m/s
wf=0.86;
P=(Cw*Cb*wf)/1000;
CP=12*P;
T=20+273;
y=1.4;
ET=T*6^[(y-1)/y];
cp=1.005;
sp=cp*(ET-T);
Ce=sp/CP;
disp("%",Ce*100,"compressor isintropic efficiency is
   :");
```

Scilab code Exa 11.10 10

```
clc;
T=20+273;
y=1.4;
Ti=T*4^([y-1]/y)
ir=Ti-T;
actual_r=ir/0.8;
cp=1.005;
P=cp*actual_r;
Cai=150;
Cbi=15000*%pi*250/(60*10^3);
Cwi=Cai*sin(25*%pi/180);
Cbe=15000*%pi*590/(60*10^3);
Cwe=Cbe;
```

```
P=178.9*10^3;
C_we=(P+Cbi*Cwi)/(Cbe);
Sf=C_we/Cwe;
disp(Sf,"Slip factor is:");
```

Chapter 12

Positive Displacement Machines

Scilab code Exa 12.4 4

```
clc;
Va_Vd=14/(300*2);
p2=7;
p1=1.013;
n=1.3;
Vs=Va_Vd/[(1.05)-(0.05*[(p2/p1)^(1/n)])];
disp("swept volume of compressor is:");
disp("m^3",Vs);

T1=288;//K
T2=T1*[(p2/p1)^([n-1]/n)];
disp("delivery temperature is:");
disp("K",T2);

V=14/60;
P=[n/(n-1)]*{[p1*V*10^5]/(10^3)}*{[(p2/p1)^[(n-1)/n
   ]]-1};
disp("indicated power is:");
disp("kW",P)
```

Scilab code Exa 12.7 7

```
clc;
p=1.013;//bar
V=2.83;//m^3
R=0.287;
T=288;//K

m_deliv=p*V*10^5/(T*R*10^3);

n=1.3;
z=3;
p2=70;//bar
p1=0.98;//bar
m=m_deliv/60;

T_P=z*[n/(n-1)]*m*R*T*{[(p2/p1)^[(n-1)/(3*n)]]-1};
disp("kW",T_P,"Total indicated powar is:");
```

Scilab code Exa 12.10 10

```
clc;
//part I
p1=6.3;//bar
V1!V2=0.55/1.05;
n=1.3;
p2=p1*[(V1!V2)^n];

T1=297;
T2=T1*[(V1!V2)^[n-1]];
disp("Temperature after expansion is:");
```

```
disp("C",T2-273);


//part II
p4=1.013;//bar
V4!V5=0.1/0.05;
p5=p4*[(V4!V5)^n];

A=%pi*(63.5)^2;
sweptV=A*114/(4*10^9);

V1_V6=0.5;
V1=0.55;
V2=1.05;
p=1.013;
p3=p;
V3_V4=0.95
V5=0.05;
V4=0.1;
W_op=[10^5*0.361*10^-3]*[p1*(V1_V6)+[(p1*V1-p2*V2)
    /0.3]-p*V3_V4-[(p5*V5)-p*V4]/0.3]
disp("powar developed is:");
P=W_op*300/(60*010^3);
disp(P);

//part III
y=1.4;
T3=T2*(p3/p2)^((y-1)/y)

T4=T3
R=287
m4=p4*V4*[10^5*0.361*10^-3]/(R*T4);
m1=p1*V1*[10^5*0.361*10^-3]/(R*T1);
ind_mass=(m1-m4);
rate=ind_mass*300;
disp("mass flow rate of air supplied is;");
disp("kg/min",rate)
```

Chapter 13

Reciprocating Internal Combustion Engines

Scilab code Exa 13.1 1

```
clc;
W=155;
R=0.356;
T=W*R;
disp("N m",T,"Torque is:")

N=2800/60;
bp=2*%pi*N*T/1000;
A=%pi*0.057^2;
L=0.09/4;
n=4;
bmep=bp*2*10^3/(A*L*N*n*10^5)
disp("bar",bmep,"bmep is:")

spc_grv=0.735;
fc=6.74
m=(fc/3600)*spc_grv
Q=44200;
disp(m)
```

```
eff_BT=bp/(m*Q)
disp("%",eff_BT*100,"brake thermal efficiency is:");

sfc=m/(bp)*3600;
disp("specific fuel consumption is");
disp("kg/kW h",sfc);
```

Scilab code Exa 13.2 2

```
clc;
spc_grv=0.735;
fc=6.74
m=(fc/3600)*spc_grv;
AMflow=14.5*m;
R=287;
T=288;//K
p=1.013;//bar
V_drawn=AMflow*R*T/(p*10^5)

N=2800/60;
A=%pi*0.057^2;
L=0.09/4;
n=4;
sweptV=A*L*N*n/2;//m^3/min

eff=V_drawn/sweptV;
disp("eff is:")
disp("%",eff*100)
```

Scilab code Exa 13.3 3

```
clc;
R=0.287
```

```
capct=0.003;//m^3
sweptV=3500/2*capct;
ind_V=0.8*sweptV;
p=1.013;
blow_p=1.7*p;
T=288;//K
y=1.4;
T_comp=T*1.7^[(y-1)/y];
blow_T=T+[T_comp-T]/0.75;

eq_V=sweptV*blow_p*T/(p*blow_T);
inc_ind_V=eq_V-ind_V;

inc_ip=[(blow_p-p)*10^5*sweptV]/(10^3*60);
Total=40.2+inc_ip;

inc_bp=0.8*Total;

mass_delv=blow_p*10^5*sweptV/(60*R*blow_T);
cp=1.005;
m=0.149;
W=m*cp*(blow_T-T);
P=W/0.8;
Net=inc_bp-P;

disp("kW",Net,"Net increase in bp")
```

Chapter 14

Refrigeration and Heat Pumps

Scilab code Exa 14.1 1

```
clc;
T1=-30+273;//K
T2=32+273;//K

COP=T1/(T2-T1);

eff=0.75;
acctual_COP=eff*(COP);

Q=5;//kW
W=Q/acctual_COP;

disp("required powar input is:");
disp("kW",W);
```

Scilab code Exa 14.6 6

```
clc;
```

```
h1=301;//K
h2=330;//K
h4=145.5;//K

COP=(h1-h4)/(h2-h1);
disp("COP is:");
disp(COP)
```

Scilab code Exa 14.8 8

```
clc;
h3=162.93;
hf1=120.06;
hg1=303.38;
hfg1=hg1-hf1;
x=(h3-hf1)/hfg1;
disp("the amount of vapour bled off at the flash
   chamber:");
disp(x);

//part II
s1=1.7155;//kJ/kg K
s2=s1;
s3=1.7071;
s4=1.7463;
h2=hg1+[(s1-s3)/(s4-s3)]*(314.86-hg1);
h3={(1-x)*h2}+x*hg1;

disp(h3,"h3=")
disp("hence vapour at inlet to the second stage
   compressor is still superheated")

//part III
h1=291.77;
h4=120.06;
```

```
Refrigerating=(1-x)*(h1-h4);
disp("refrigerating effect is:");
disp("kJ/kg",Refrigerating);

//part IV
h5=305.26;//kJ/kg
s5=s3+[(h3-hg1)/(h2-hg1)]*(s1-s3);

h6=319.54+[(s5-1.7028)/(1.7440-1.7028)]*(332.87-319.54);

W=(1-x)*(h2-h1)+(h6-h5);
disp("kJ/kg",W,"Work done per unit mass of refrigerant in the condenser is:");

//part V
Q=131.53;//W
COP=Q/W;
h2=319.54+[(s1-1.7028)/(1.7440-1.7028)]*(332.87-319.54);

h4=162.93;
W=(h2-h1);
Q=(h1-h4);

disp("coefficient of performance is:");
disp(COP);
```

Chapter 15

Psychrometry And Air Conditioning

Scilab code Exa 15.5 5

```
clc;
sensible_heat=18000;//W
latent_heat=3600;//W
total_heat=sensible_heat+latent_heat;
w4=0.0089;
w1=0.0075;
wA=w4-(w4-w1)/0.8;

h1=33.9;//kJ/kg
h2=40.2;//kJ/kg

mn1=total_heat/(h2-h1);
mass_flow_rate=mn1*(1+w1);
disp("mass flow rate of supply air is:");
disp("kg/s",mass_flow_rate/1000);

//part II
humidity=0.00745;
h4=46.2;//kJ/kg
```

```
h5=31.1;//kJ/kg
cooling_load=mn1*(h4-h5);
disp("cooling load on washer is:");
disp("kW",cooling_load/1000);

//part III
h6=33.9;//kJ/kg
heat_load=mn1*(h6-h5);
disp("heating load is:");
disp("kw",heat_load/1000)
```

Chapter 16

Heat Transfer

Scilab code Exa 16.1 1

```
clc;
lambda=10^3*0.52;
x=250;
t1=40;
t2=20;
q=lambda*(t1-t2)/x;
disp("rate of heat transfer per unit area:");
disp("W/m^2",q);
```

Scilab code Exa 16.2 2

```
clc;
alpha_a=2800;
lambda=10^3*50;
x=10;
alpha_b=11;
U=1/[1/alpha_a+x/lambda+1/alpha_b];

```

```
tA=90;
tB=15;
q=(tA-tB)*U;
disp("rate of heat lost per sq m of surface")
disp("kW",q)

//part b
t2=q/alpha_b+tB;
disp("temperature of outsede surface:");
disp("C",t2)
```

Scilab code Exa 16.7 7

```
clc;
alpha=88.8;
L=0.05;
lambda=40;
Bi=alpha*L/lambda;
//p1L*[cos(p1L)/sin(p1L)]=1-Bi;
//from trial and error;
p1L=0.57;

tou=20*60;
rho=7600;
c=0.5*10^3;
R=0.05;
F0=lambda*tou/(rho*c*R^2);

tF=20;
ti=500;
a=(sin(p1L)-p1L*cos(p1L))*(2*%e^[-(p1L)^2*F0])/(p1L-
   sin(p1L)*cos(p1L));
tc=tF+a*(ti-tF);
disp("temperature of center is:")
disp("C",tc)
```

```

//part b
tc=tF+[%e^(-3*Bi*F0)]*(ti-tF)
disp("temperature of center by newtonian cooling is:
   ")
disp("C",tc)
```

Scilab code Exa 16.12 12

```
clc;
delta_p=0.0002;//bar
d=25;
rho=7600;//assumed to run program
c=1.13;
C=24;
tou=delta_p*10^5*d/(4*10^3);
f=tou/(rho*C^2/2);
alpha=0.125*rho*c*C/(rho*C^2);
disp("heat transfer coefficient is:");;
disp("kW/m^2 K",alpha);
```

Scilab code Exa 16.15 15

```
clc;
delta_t=277-17;
d=0.15;
alpha=1.32*(delta_t/d)^0.25;
disp("heat transfer coefficient=");
disp("W/m^2 K",alpha);
```

Scilab code Exa 16.16 16

```
clc;
Beta=1/303;
g=9.81;
l=1;
delta_t=327-30;
v=(5.128*10^-5);
Gr=Beta*g*l^3*delta_t/v^2

alpha=1.31*delta_t^0.33333
A=1;//m^2
delta_t=627-27;
Q=alpha*A*delta_t
disp("rate of heat loss:");
disp("kW",Q/1000);
```

Scilab code Exa 16.18 18

```
clc;
m=3;
rho=500;
v=m/rho;

l=4;//m
r=0.01;
A=%pi*r^2;
n=v*l/A;
disp("number of tumes is:");
disp(n)

alpha0=260;
A0=12.7;
alphai=580;
Ai=10;
```

```
U=1/[1/alpha0+A0/(alphai*Ai)];
N=U*%pi*(A0/1000)*l*n/(3*1.5*1000);
R=3*1.5/(40*1.04);

eta=[1-%e^(-N*(1-R))]/[1-R*%e^(-N*(1-R))]
disp(eta,"eta is:");

t2=400;
t1=100;
tL=eta*(t2-t1)+t1
disp("exit temperature is :");
disp(tL);
```

Scilab code Exa 16.21 21

```
clc;
eta=0.4;
sigma=5.67;
T1=13.73;
T2=3.13;
q=eta*sigma*(T1^4-T2^4);
disp("heat loss by radiation is:");
disp("kW",q/1000);

eta2=0.9;
q1=eta*sigma*T1^4;
q2=eta2*sigma*T2^4
q_=q1-q2;
disp("grey body assumptions overstimates by:");
pct=(q-q_)/q_
disp("%",pct*100)
```

Scilab code Exa 16.25 25

```
clc;
eta=0.8;
F1_2=5.67*10^-8;
T1=533;//K
T2=293;//K
alpha=eta*F1_2*(T1^2+T2^2)*(T1+T2);

A=%pi*0.6*0.9;
Q1=alpha*A*(T1-T2);

alpha=8.8;
A=5;
Q2=alpha*A*(T1-T2);

Q=Q1+Q2;
disp("total heat loss is:");
disp("kW",Q/1000)
```

Chapter 17

The Source Use and Management of Energy

Scilab code Exa 17.1 1

```
clc;
T1=15+273;//K
p2!p1=8;
y1=1.4;
T2s=T1*([p2!p1]^[(y1-1)/y1]);

T2=T1+(T2s-T1)/0.8;

T3=800+273;//K
p3!p4=p2!p1
y2=1.333;
T4s=T3/[(p3!p4)^([y2-1]/y2)];

T4=T3-0.82*(T3-T4s)

cv=1.11;
cp=1.005;
W=[cv*(T3-T4)-cp*(T2-T1)];

```

```
heat_supp=cv*(T3-T2);

cycle_eff=W/heat_supp;
disp("cycle efficiency is :")
disp("%",cycle_eff*100);//end of part I

//part II
h1=3248;//kJ/kg
h3=138;//kJ/kg
h4=h3;
h2s=2173;//kJ/kg
W=0.8*(h1-h2s);

steam_heat_supp=h1-h3;
steam_cycle_eff=W/steam_heat_supp;
disp("steam cycle efficiency is:");
disp(steam_cycle_eff*100)
```

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```
clc;
boiler_eff=71;//%
slope=20;//GJ/D daly
space_heat=boiler_eff/100*slope;
base_load_zero=10000;//GJ/month
base_load=boiler_eff/100*base_load_zero;
consume=1000;//GJ
base_load_new=base_load+consume;

new_eff=75;//%
new_base_load=base_load_new*100/new_eff;
new_space_heat=space_heat/new_eff*100;

//part I
disp(new_space_heat)
```

```
annual_consum=12*new_base_load+2527*new_space_heat;
disp("annual consumption is:")
disp("GJ/annum",annual_consum);

//part II
max_consum=new_base_load+(379*new_space_heat);
disp("fuel consumption in january is:")
disp("GJ/month",max_consum);

//part III
enrgy_consume=12*base_load_new/boiler_eff*100;
original_space_heat=2527*20;
saving=enrgy_consume+original_space_heat-annual_consum;
disp("enegy saving is:");
disp("GJ/annum",saving);
```