Scilab Textbook Companion for Introduction to Thermal Systems Engineering: Thermodynamics, Fluid Mechanics, and Heat Transfer by M. J. Moran[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.

Contents

List of Scilab Codes 4

3 Using Energy and First Law of thermodynamics 5

4 Evaluating Properties 9

5 Control Volume Analysis Using Energy 15

6 The Second Law of Thermodynamics 19

7 Using Entropy 21

8 Vapor Power and Refrigeration Sysytem 26

9 Gas Power Systems 31

10 Psychrometric Operations 36

11 Getting Started in Fluid Mechanics 41

12 The Momentum and Mechanical Energy Equations 44

14 Internal and External Flow 49

15 Getting Started in Heat Transfer 53

16 Heat Transfer by Conduction **56**

17 Heat transfer by Convection **62**

18 Heat transfer by radiation **71**

List of Scilab Codes

Exa 3.1	1	5
Exa 3.2	2	6
Exa 3.3	3	6
Exa 3.4	4	7
Exa 3.5	5	7
Exa 3.6	6	8
Exa 4.1	1	9
Exa 4.2	2	10
Exa 4.3	3	10
Exa 4.4	4	11
Exa 4.6	6	11
Exa 4.7	7	12
Exa 4.8	8	12
Exa 4.10	10	13
Exa 4.11	11	13
Exa 5.1	1	15
Exa 5.3	3	15
Exa 5.4	4	16
Exa 5.5	5	17
Exa 5.7	7	17
Exa 5.8	8	18
Exa 5.9	9	18
Exa 6.1	1	19
Exa 6.2	2	19
Exa 6.3	3	20
Exa 7.1	1	21
Exa 7.2	2	21
Exa 7.4	4	22

Exa 7.5 5 22
Exa 7.6 6 23
Exa 7.8 8 23
Exa 7.9 9 24
Exa 7.10 10 24
Exa 7.13 13 25
Exa 8.1 1 26
Exa 8.2 2 27
Exa 8.3 3 27
Exa 8.4 4 28
Exa 8.5 5 29
Exa 8.6 6 29
Exa 8.7 7 30
Exa 9.1 1 31
Exa 9.2 2 32
Exa 9.3 3 33
Exa 9.4 4 33
Exa 9.5 5 34
Exa 9.6 6 34
Exa 10.1 1 36
Exa 10.2 2 36
Exa 10.3 3 37
Exa 10.4 4 38
Exa 10.5 5 38
Exa 10.6 6 39
Exa 10.7 7 40
Exa 11.1 1 41
Exa 11.2 2 42
Exa 11.3 3 42
Exa 12.1 1 44
Exa 12.2 2 44
Exa 12.3 3 45
Exa 12.5 5 46
Exa 12.6 6 46
Exa 12.7 7 46
Exa 12.8 8 47
Exa 12.9 9 47
Exa 14.1 1 49

Exa 14.2	2	49
Exa 14.3	3	50
Exa 14.7	7	51
Exa 14.8	8	51
Exa 14.9	9	52
Exa 15.1	1	53
Exa 15.2	2	53
Exa 15.5	5	54
Exa 15.6	6	55
Exa 16.1	1	56
Exa 16.2	2	56
Exa 16.3	3	57
Exa 16.4	4	57
Exa 16.6	6	58
Exa 16.7	7	58
Exa 16.8	8	59
Exa 16.9	9	60
Exa 16.10	10	60
Exa 17.1	1	62
Exa 17.2	2	62
Exa 17.3	3	63
Exa 17.4	4	63
Exa 17.5	5	64
Exa 17.6	6	65
Exa 17.7	7	65
Exa 17.9	9	66
Exa 17.10	10	67
Exa 17.11	11	67
Exa 17.12	12	68
Exa 17.13	13	68
Exa 17.14	14	69
Exa 17.15	15	70
Exa 18.1	1	71
Exa 18.2	2	71
Exa 18.4	4	72
Exa 18.5	5	73
Exa 18.6	6	73
Exa 18.7	7	74

Exa 18.8 8 74
Exa 18.9 9 75
Exa 18.10 10 76

Chapter 3

Using Energy and First Law of thermodynamics

Scilab code Exa 3.1 1

```

//example 3.1
clc; funcprot(0);
// Initialization of Variable
V1=0.1;
V2=0.2;
P1=3.0;//pressure
n1=1.5;
n2=1.0;
n3=0.0;
P2=P1*(V1/V2)^n1;
W=(P2*V2-P1*V1)/(1-n1);
disp(W*100,"work done in kj");
W2=P1*V1*log(V2/V1);
disp(W2*100,"work done in kj");
W3=P1*(V2-V1);
disp(W3*100,"work done in kj");
clear()
```

Scilab code Exa 3.2 2

```


//example 3.2
clc; funcprot(0);
// Initialization of Variable
k=-4.6;//u2-u1;
W=17.6;//work done
m=4;//mass
Q=W+m*k;
disp(Q,"Energy transferred in kJ");
clear()
```

Scilab code Exa 3.3 3

```
//example 3.3
clc; funcprot(0);
// Initialization of Variable
patm=14.7;//in lbf/in^2
mpiston=100;
g=32.2;
A=1;//area
mair=0.6;
delu=18;
k=1.6;//V2-V1;
P=mpiston*g/A/32.2/144+14.7;
W=P*k*144/778;
Q=W+mair*delu;
disp(Q,"Heat transferred in Btu")
W2=patm*k*144/778;
disp(W2,"Work done in Btu");
```

```
delz=k/A;
PE=mpiston*g*delz/32.2/778;
Q2=W2+PE+mair*delu;
disp(Q2,"Heat transferred in Btu")
clear()
```

Scilab code Exa 3.4 4

```

//example 3.4
clc; funcprot(0);
// Initialization of Variable
h=-0.171;
A=1;
Tb=300;//temperature
Tf=293;//temperature
W1dot=-60.0;
Qdot=h*A*(Tb-Tf);
disp(Qdot,"the rate of heat transfer in kW");
W2dot=Qdot-W1dot;
disp(W2dot,"the rate of energy transfer in kW");
clear()
```

Scilab code Exa 3.5 5

```
//example 3.5
clc; funcprot(0);
// Initialization of Variable
Wdot=-0.225;
A=25.0e-6;
h=150;
Tf=293;//temperature
Tb=-Wdot/h/A+Tf;
```

```
disp(Tb,"temperature in kelvin (80 C)");
clear()
```

Scilab code Exa 3.6 6

```
//example 3.6
clc; funcprot(0);
// Initialization of Variable
clf()
t=linspace(0,100,11);
tau=18;
omega=100;
Wdotelec=-2.0;
Wdotshaft=tau*omega/1000;
Wdot=Wdotelec+Wdotshaft;
Q=0.2*2.71^-(0.05*t);
delE=4*(1-2.71^-(0.05*t));
plot(t,Q);
plot(t,delE,'r');
xtitle('Q or delE vs t','time','Q(blue)or delE(red)'
    );
clear()
```

Chapter 4

Evaluating Properties

Scilab code Exa 4.1 1

```
//example 4.1
clc; funcprot(0);
// Initialization of Variable
V=0.5;//volume
P1=1;//pressure
P2=0.5;
vf1=1.0432/1000;
vf2=1.0582/1000;
x=0.5;
T1=99.63;
v1=vf1+0.5*(1.694-vf1);
v2=v1;
T2=111.4;//from table
disp(T2,"temperature in degree celcius");
m=V/v1;
mg1=x*m;
disp(mg1,"mass of vapor in kg");
x2=(v1-vf2)/(1.159-vf2);
mg2=x2*m;
disp(mg2,"mass of vapor in kg");
clear()
```

Scilab code Exa 4.2 2

```
//example 4.2
clc; funcprot(0);
// Initialization of Variable
m=0.1;
v1=2.2661;
P2=20;//pressure
v2=2.6704;
V1=m*v1;
disp(V1,"volume in ft^3");
V2=m*v2;
disp(V2,"volume in ft^3");
W=P2*(V2-V1)*144/778;
disp(W,"Work done in Btu");
clear()
```

Scilab code Exa 4.3 3

```
//example 4.3
clc; funcprot(0);
// Initialization of Variable
V=10.0;//ft^3
v1=26.8;//ft^3/lb
u1=1077.6;//btu/lb
u2=1161.6;//Btu/lb;
m=V/v1;
W=-m*(u2-u1);
disp(W,"Work done in Btu");
clear()
```

Scilab code Exa 4.4 4

```
//example 4.4
clc; funcprot(0);
// Initialization of Variable
P=10;//pressure
v2=0.1944;//volume
v1=0.3066;//volume
uf3=631.68;
v3=0.1944;
vg3=0.3928;
vf3=1.0905/1000;
x3=(v3-vf3)/(vg3-vf3);
u3=uf3+x3*(2559.5-uf3);
k1=P*(v2-v1)*100;//k=W/m
k2=u3-2957.3+k1;//k2=Q/m
disp(k2,"Q/m in kJ/kg");
clear()
```

Scilab code Exa 4.6 6

```
//example 4.6
clc; funcprot(0);
// Initialization of Variable
Tr1=793.0/647.3;
Pr1=22.0/22.09;
Rbar=8314.0;
M=18.02;
T1=793.0;
P1=20.0e6;
pr2=0.69;
v1=0.83*Rbar/M/P1*T1;
```

```
disp(v1,"Specific weight in m^3/kg");
vrdash=v1*22.09e6/Rbar*M/647.3;
Tr2=673/647.3;
P2=22.09e6*pr2;
disp(P2/10^6,"Pressure in Mpa");
clear()
```

Scilab code Exa 4.7 7

```
//example 4.7
clc; funcprot(0);
// Initialization of Variable
p2=2;//pressure
p1=1;//pressure
T1=540;//temperature
Rbar=1545;
M=28.97;
P1=14.7*144;
T2=p2/p1*T1;
disp(T2,"temperature in degreeR");
v3=Rbar/M*T2/P1;
disp(v3,"specific volume in ft^3/lb");
clear()
```

Scilab code Exa 4.8 8

```
//example 4.8
clc; funcprot(0);
// Initialization of Variable
Q=-20;
m=2;
u2=143.98;
u1=92.04;
```

```
W=Q-m*(u2-u1);
disp(W,"work done on the system in Btu");
clear()
```

Scilab code Exa 4.10 10

```
//example 4.10
clc; funcprot(0);
// Initialization of Variable
m1=2;
m2=8;
T1=350;
T2=300;
P1=0.7;//bar
P2=1.2;//bar
Tf=315;//K
cv=0.745;//heat capacity
pf=(m1+m2)*Tf/(m1*T1/P1+m2*T2/P2);
disp(pf,"final pressure in bar");
Q=m1*cv*(Tf-T1)+m2*cv*(Tf-T2);
disp(Q,"heat transfer into the system in kJ");
clear()
```

Scilab code Exa 4.11 11

```
//example 4.11
clc; funcprot(0);
// Initialization of Variable
P2=5.0;
P1=1.0;
n=1.3;
T1=530;
R=1.986;
```

```
u2=131.88;
u1=90.33;
T2=T1*(P2/P1)^(.3/n);
k1=R*(T2-T1)/(1-n)/28.97;//k1=W/m
disp(k1,"W/m in Btu/lb");
k2=k1+u2-u1;//k2=Q/m
disp(k2,"Q/m in Btu/lb");
clear()
```

Chapter 5

Control Volume Analysis Using Energy

Scilab code Exa 5.1 1

```
//example 5.1
clc; funcprot(0);
// Initialization of Variable
v3=1.108e-3;
m1dot=40;
A2=25.0e-4;
v2=1.0078e-3;
m3dot=0.06/v3;
m2dot=m3dot-m1dot;
disp(m2dot,"mass flow rate in kg/s");
V2=m2dot*v2/A2;
disp(V2,"velocity in m/s");
clear()
```

Scilab code Exa 5.3 3

```
//example 5.3
clc; funcprot(0);
// Initialization of Variable
h1=3213.6;//kJ/kg
V1=10.0;
V2=665.0;
mdot=2.0;
h2=h1+(V1^2/2-V2^2/2)/1000;
//using table with given h2 values
v2=0.1627;//specific volume
V2=665;
A2=mdot*v2/V2;
disp(A2,"Area in m^2");
clear()
```

Scilab code Exa 5.4 4

```
//example 5.4
clc; funcprot(0);
// Initialization of Variable
h1=3177.2;
x2=0.9;
hf2=191.83;
mdot=4600.0;
Wcvdot=1000.0;
V2=50.0;//velocity
V1=10.0;//velocity
h2=hf2+x2*2392.8;
k1=h2-h1;
k2=(V2^2/2-V1^2/2)/1000.0;
Qcvdot=Wcvdot+mdot*(k1+k2)/3600;
disp(Qcvdot,"specific kinetic energy difference in kW");
clear()
```

Scilab code Exa 5.5 5

```
//example 5.5
clc; funcprot(0);
// Initialization of Variable
A1=0.1;
V1=6.0;
V2=2.0;
delh=290.16-451.8;
p1=10^5;
Rbar=8314.0;
Qcvdot=-180.0/60;
M=28.97;//molecular mass
T1=290.0;
mdot=A1*V1*p1*M/Rbar/T1;
Wcvdot=Qcvdot+mdot*(delh+(V1^2/2-V2^2/2)/1000);
disp(Wcvdot,"heat transfer per unit time in kW")
clear()
```

Scilab code Exa 5.7 7

```
//example 5.7
clc; funcprot(0);
// Initialization of Variable
h1=2465.1;
h2=188.45;
k=62.7;//h3-h4;
k2=(h1-h2)/k;
disp(k2,"m3dot/m1dot is");
k3=h2-h1;
disp(k3,"Qcvdot/m1dot in kJ/kg");
clear()
```

Scilab code Exa 5.8 8

```
//example 5.8
clc; funcprot(0);
// Initialization of Variable
v1=1.3;
cp=1.005;
p1=1.01325*10^5;
T2=305;
T1=293;
pi=3.14;
Wcvdot=-98.0;
A1=1/v1*(-Wcvdot/cp/(T2-T1)/1000)*8314/28.97*T1/p1;
D1=sqroot(4*A1/pi)*100;
disp(round(D1),"minmum diameter required in cm");
clear()
```

Scilab code Exa 5.9 9

```
//example 5.9
clc; funcprot(0);
// Initialization of Variable
hf1=394.1;
hg1=1203.9;
h2=1168.8;
x1=(h2-hf1)/(hg1-hf1);
disp(x1*100,"the quality of line in %");
clear()
```

Chapter 6

The Second Law of Thermodynamics

Scilab code Exa 6.1 1

```
//example 6.1
clc; funcprot(0);
// Initialization of Variable
Input=1000.0;
Tc=300.0;
Th=500.0;
Output=410.0;
neta=Output/Input*100;
nmax=(1-Tc/Th)*100;
disp(neta,"efficiency in %");
disp(nmax,"maximum efficiency in %");
disp("the system cannot exist");
clear()
```

Scilab code Exa 6.2 2

```
//example 6.2
clc; funcprot(0);
// Initialization of Variable
Qcdot=8000;
Wcycledot=3200.0;
Tc=268.0;
Th=295.0;
Beta=Qcdot/Wcycledot;
disp(Beta,"coeff. of performance");
Betamax=Tc/(Th-Tc);
disp(Betamax,"maximum coeff. of performance");
clear()
```

Scilab code Exa 6.3 3

```
//example 6.3
clc; funcprot(0);
// Initialization of Variable
Tc=492;
Th=530;//temperature
Qh=6e5;
Wcycle=(1-Tc/Th)*Qh;
disp(Wcycle,"Minimum Work input theoritical in Btu/
    day");
MTC=Wcycle/3413*0.08;
disp(MTC,"Minimum cost theoritical in $/day");
clear()
```

Chapter 7

Using Entropy

Scilab code Exa 7.1 1

```
//example 7.1
clc; funcprot(0);
// Initialization of Variable
P=1.014;
vg=1.673;
vf=1.0435/1000;
T=373.15;//temperature
sg=7.3549;
sf=1.3069;
k=P*(vg-vf)*10^5/1000;
disp(k,"W/m in kJ/kg");
k1=T*(sg-sf);
disp(k1,"Q/m in kJ/kg");
clear()
```

Scilab code Exa 7.2 2

```
//example 7.2
```

```
clc; funcprot(0);
// Initialization of Variable
k=-2087.56;//from table t2
disp(k,"W/m in kJ/kg");
k1=6.048;//from table t2
disp(k1,"sigma/m in kJ/kg/K");
clear()
```

Scilab code Exa 7.4 4

```
//example 7.4
clc; funcprot(0);
// Initialization of Variable
Qdot=-1.2;
Tb=300.0;
Tf=293.0;
sigmadot=-Qdot/Tb;
disp(sigmadot,"heat transfer rate in kW/K");
sigmadot1=-Qdot/Tb;
disp(sigmadot1,"heat transfer rate in kW/K");
clear()
```

Scilab code Exa 7.5 5

```
//example 7.5
clc; funcprot(0);
// Initialization of Variable
k1=540.0;//Wcv/m
h2=2676.1;
h1=3230.9;
V2=100;
V1=160;
s2=7.3549;
```

```
s1=6.9212;
k2=k1+(h2-h1)+(V2^2/2-V1^2/2)/1000;
disp(k2,"Qcvdot/mdot in kJ/kg");
k3=-k2/350+(s2-s1);
disp(k3,"sigmacvdot/mdot in kJ/kg/K");
clear()
```

Scilab code Exa 7.6 6

```
//example 7.6
clc; funcprot(0);
// Initialization of Variable
T2=635;//temperature
T1=530;//temperature
T3=460;//temperature
P2=1;//pressure
P3=1;//pressure
P1=5.1;//pressure
cp=0.24;
R=1.986/28.97;
k1=-105;//T1-T2
k2=70;//T1-T3
a=0.4*k1+0.6*k2;
disp(a,"since  mass is conserved thus value is ");
k=0.4*(cp*log(T2/T1)-R*log(P2/P1))+0.6*(cp*log(T3/T1
    )-R*log(P3/P1));
disp(k,"sigmacvdot/m1dot in Btu/lb/R");
disp("thus second law of thermodynamics is also
    conserved");
clear()
```

Scilab code Exa 7.8 8

```
//example 7.8
clc; funcprot(0);
// Initialization of Variable
p1=1;//pressure
pr2=21.18;
pr1=1.3860;
k=1.39;
T2=1160;//temperature
T1=540;//temperature
p=p1*pr2/pr1;
disp(p,"pressure in atm");
p2=p1*(T2/T1)^(k/(k-1));
disp(p2,"Pressure final in atm");
clear()
```

Scilab code Exa 7.9 9

```
//example 7.9
clc; funcprot(0);
// Initialization of Variable
h1=3105.6;
h2s=2743.0;
nt=0.75;//effeiciency
k=nt*(h1-h2s);
disp(k,"Wcvdot/mdot in kJ/kg");
clear()
```

Scilab code Exa 7.10 10

```
//example 7.10
clc; funcprot(0);
// Initialization of Variable
h1=390.88;
```

```
h2s=285.27;
k=74.0;//Wcvdot/mdot
ks=h1-h2s;//(Wcvdot/mdot)s
nt=k/ks*100;
disp(nt,"efficiency in %");
clear()
```

Scilab code Exa 7.13 13

```
//example 7.13
clc; funcprot(0);
// Initialization of Variable
T1=293;//kelvin
p2=5;//atm
p1=1;//atm
n=1.3;
h2=426.35;
h1=293.17;
T2=T1*(p2/p1)^((n-1)/n);
k=-n*8.314/28.97*(T2-T1)/(n-1);//Wcvdot/mdot
disp(k,"Wcvdot/mdot in kJ/kg");
k1=k+h2-h1;
disp(k1,"Qcvdot/mdot in kJ/kg");
clear()
```

Chapter 8

Vapor Power and Refrigeration Sysytem

Scilab code Exa 8.1 1

```
//example 8.1
clc; funcprot(0);
// Initialization of Variable
h1=2758.0;
h2=1794.8;
h3=173.88;
h4=h3+1.0084/1000*(8-0.008)*1000;
neta=(h1-h2-h4+h3)/(h1-h4);
disp(neta*100,"thermal efficiency in %");
bwr=(h4-h3)/(h1-h2);
disp(bwr*100,"back work ratio in %");
mdot=100*1000*3600/(h1-h2-h4+h3);
disp(mdot,"mass flow rate in kg/h");
Qindot=mdot*(h1-h4)/3600/1000;
disp(Qindot,"energy inflow rate in MW");
Qoutdot=mdot*(h2-h3)/3600/1000;
disp(Qoutdot,"energy outflow rate in MW");
disp(Qoutdot/Qindot*100,"ratio of energy outflow/
    inflow in %");
```

```
mcwdot=mdot*(h2-h3)/(146.68-62.99);
disp(mcwdot,"mass flow rate in kg/h");
clear()
```

Scilab code Exa 8.2 2

```
//example 8.2
clc; funcprot(0);
// Initialization of Variable
h1=2758.0;
h2=1939.3;
h3=173.88;
h4=h3+8.06/0.85;
neta=(h1-h2-h4+h3)/(h1-h4);
disp(neta*100,"thermal efficiency in %");
mdot=100*1000*3600/(h1-h2-h4+h3);
disp(mdot,"mass flow rate in kg/h");
Qindot=mdot*(h1-h4)/3600/1000;
disp(Qindot,"energy inflow rate in MW");
Qoutdot=mdot*(h2-h3)/3600/1000;
disp(Qoutdot,"energy outflow rate in MW");
mcwdot=mdot*(h2-h3)/(146.68-62.99);
disp(mcwdot,"mass flow rate in kg/h");
clear()
```

Scilab code Exa 8.3 3

```
//example 8.3
clc; funcprot(0);
// Initialization of Variable
h1=3348.4;
h2=2741.8;
h3=3353.3;
```

```
h4=2428.5;
h6=181.94;
h5=173.88;
neta=(h1-h2-h4+h3-h6+h5)/(h1-h6+h3-h2);
disp(neta*100,"thermal efficiency in %");
mdot=100*1000*3600/(h1-h2-h4+h3-h6+h5);
disp(mdot,"mass flow rate in kg/h");
Qoutdot=mdot*(h4-h5)/3600/1000;
disp(Qoutdot,"energy outflow rate in MW");
//part2
h2=2832.8;
h4=2567.2;
neta=(h1-h2-h4+h3-h6+h5)/(h1-h6+h3-h2);
disp(neta*100,"thermal efficiency in %");
clear()
```

Scilab code Exa 8.4 4

```
//example 8.4
clc; funcprot(0);
// Initialization of Variable
h1=3348.4;
h7=705.3;
h6=697.22;
h5=174.6;
h4=173.88;
h2=2832.8;
h3=2249.3;
k1=h1-h2+0.8034*(h2-h3);//Wt/m1
k2=h7-h6+0.8034*(h5-h4);//Wp/m1
k3=h1-h7;//Qin/m1
neta=(k1-k2)/k3;
disp(neta*100,"thermal efficiency in %");
m1dot=100*1000*3600/(k1-k2);
disp(m1dot,"mass flow rate in kg/h");
```

```
clear()
```

Scilab code Exa 8.5 5

```
//example 8.5
clc; funcprot(0);
// Initialization of Variable
mdot=0.08;
h2s=264.7;
h1=247.23;
h4=85.75;
Th=299.0;
Wcdot=mdot*(h2s-h1);
disp(Wcdot,"work input in kW");
Qindot=mdot*(h1-h4)*60.0/211;
disp(Qindot,"refrigration capacity in ton");
Beta=(h1-h4)/(h2s-h1);
disp(Beta,"coefficient of performance");
Bmax=273/(Th-273);
disp(Bmax,"maximum coefficient of performance");
clear()
```

Scilab code Exa 8.6 6

```
//example 8.6
clc; funcprot(0);
// Initialization of Variable
h2s=272.39;
h1=241.35;
mdot=0.08;
h4=99.56;
Wcdot=mdot*(h2s-h1);
disp(Wcdot,"work input in kW");
```

```
Qindot=mdot*(h1-h4)*60.0/211;
disp(Qindot,"refrigration capacity in ton");
Beta=(h1-h4)/(h2s-h1);
disp(Beta,"coefficient of performance");
clear()
```

Scilab code Exa 8.7 7

```
//example 8.7
clc; funcprot(0);
// Initialization of Variable
h1=241.35;
h2s=272.39;
nc=0.8;//efficiency
h4=91.49;
h2=(h2s-h1)/nc+h1;
mdot=0.08;
Wcdot=mdot*(h2-h1);
disp(Wcdot,"work input in kW");
Qindot=mdot*(h1-h4)*60.0/211;
disp(Qindot,"refrigration capacity in ton");
Beta=(h1-h4)/(h2-h1);
disp(Beta,"coefficient of performance");
clear()
```

Chapter 9

Gas Power Systems

Scilab code Exa 9.1 1

```
//example 9.1
clc; funcprot(0);
// Initialization of Variable
T2=1212.0;
p1=1.0;
T1=540.0;
T4=1878.0;
T3=3600.0;
u4=342.2;
u1=92.04;
u3=721.44;
u2=211.3;
m=1.47/1000;
V1=0.02;
k=8;//V1/V2
p2=k*p1*T2/T1;
disp(p2,"pressure in atm");
p3=p2*T3/T2;
disp(p3,"pressure in atm");
p4=p1*T4/T1;
disp(p4,"pressure in atm");
```

```
neta=1-(u4-u1)/(u3-u2);
disp(neta*100,"thermal efficiency in %");
W=m*(u3-u4-u2+u1);
mep=W/V1/(1-1/k)*778/144;
disp(mep,"mean effective pressure in lbf/in^2 is
   equal to 8.03 atm");
clear()
```

Scilab code Exa 9.2 2

```
//example 9.2
clc; funcprot(0);
// Initialization of Variable
T2=898.3;
T1=300.0;
T4=887.7;
vr3=3.97;
V1=0.861;
R=8314;//gas constant
u4=664.3;
u1=214.07;
h3=1999.1;
h2=930.98;
p1=0.1;
k=18.0;//V1/V2
rc=2.0;//V3/V2
p2=k*p1*T2/T1;
disp(p2,"pressure in atm");
T3=rc*T2;
disp(T3,"temperature in K");
vr4=vr3*k/rc;
p4=p1*T4/T1;
disp(p4,"pressure in atm");
neta=1-(u4-u1)/(h3-h2);
disp(neta*100,"thermal efficiency in %");
```

```
W=(h3-u4-h2+u1);//Wcycle/m
V1=R*T1/29.97/10^5;
mep=W/V1/(1-1/k)*1000/10^6;
disp(mep,"mean effective pressure in MPa");
clear()
```

Scilab code Exa 9.3 3

```
//example 9.3
clc; funcprot(0);
// Initialization of Variable
h4=808.5;
h2=579.9;
h3=1515.4;
h1=300.19;
T=300;//temperature
R=8314;//gas constant
M=28.97;//mass molecular
neta=(h3-h4-h2+h1)/(h3-h2);
disp(neta*100,"thermal efficiency in %");
bwr=(h2-h1)/(h3-h4);
disp(bwr*100,"back work ratio in %");
mdot=5*10^5*M/R/T;
Wcycledot=mdot*[h3-h4-h2+h1];
disp(Wcycledot,"net power developed in kW");
clear()
```

Scilab code Exa 9.4 4

```
//example 9.4
clc; funcprot(0);
// Initialization of Variable
h1=300.19;
```

```
k=349.6; //Wcdot/mdot
h2=h1+k;
h3=1515.4;
mdot=5.807;
k2=h3-h2; //Qindot/mdot
neta=(565.6-k)/k2;
disp(neta*100,"thermal efficiency in %");
bwr=k/565.5;
disp(bwr*100,"back work ratio in %");
Wcycledot=mdot*(565.5-k);
disp(Wcycledot,"net power developed in kW");
clear()
```

Scilab code Exa 9.5 5

```
//example 9.5
clc; funcprot(0);
// Initialization of Variable
h3=1515.4; //kJ/kg
h4=808.5; //kJ/kg
nreg=0.8;
h2=579.9; //kJ/kg
h1=300.19; //kJ/kg
hx=nreg*(h4-h2)+h2;
neta=(h3-h4-h2+h1)/(h3-hx);
disp(neta*100,"thermal efficiency in %");
clear()
```

Scilab code Exa 9.6 6

```
//example 9.6
clc; funcprot(0);
// Initialization of Variable
```

```
ha=102.7;//Btu/lb
Va=909.3;//ft/s
h3=546.54;//Btu/lb
h2=216.2;//Btu/lb
pr4=113.8;
h5=265.8;//Btu/lb
pr3=233.5;
h1=102.7+Va^2/2/32.2/778;
pr1=1.051;
pra=0.6268;
p1=pr1/pra*11.8;
disp(p1,"Pressure in lbf/in^2");
p2=8*p1;
disp(p2,"Pressure in lbf/in^2");
p3=p2;
h4=h3+h1-h2;
p4=p3*pr4/pr3;
disp(p4,"Pressure in lbf/in^2");
V5=sqroot(2*(h4-h5)*32.2*778);
disp(V5,"velocity in ft/s (2069 mi/h)");
clear()
```

Chapter 10

Psychrometric Operations

Scilab code Exa 10.1 1

```
//example 10.1
clc; funcprot(0);
// Initialization of Variable
phi=0.7;
pg=0.3632;//lbf/in^2
omega2=0.0052;
pv1=phi*pg;
omega1=0.622*pv1/(14.7-pv1);
disp(omega1,"lb(vapor)/lb(dry air) is");
mv1=1/(1/omega1+1);
ma=1-mv1;
mv2=omega2*ma;
mw=mv1-mv2;
disp(mw,"mass of water vapor that condenses in lb");
clear()
```

Scilab code Exa 10.2 2

```
//example 10.2
clc; funcprot(0);
// Initialization of Variable
phi1=0.8;
pg1=0.01228;
pa1=0.9902*10^5;;
R=8314;//gasconstant
T=283;
pv1=phi1*pg1;
va1=R/28.97*T/pa1;
madot=150/va1;
omega=0.622*(pv1/(1-pv1));
Qcvdot=madot*(303.2-283.1)+omega*(2556.3-2519.8);
disp(Qcvdot,"heat flow rate in kJ/min");
pv2=pv1;
phi2=pv2/0.04246;
disp(phi2*100,"humidity in %");
//alternatively
madot=150/0.81;
Qcvdot=madot*(45.9-25.7);
disp(Qcvdot,"heat flow rate in kJ/min");
clear()
```

Scilab code Exa 10.3 3

```
//example 10.3
clc; funcprot(0);
// Initialization of Variable
pv1=0.02123*10^5;
patm=1.013*10^5;
ha2=283.1;
ha1=303.2;
hg1=2556.3;
hg2=2519.8;
omega2=0.0076;
```

```
hf2=42.01;
T=303;//temperature
R=8314;//gas constant
M=28.97;//molecular mass
pa1=patm-pv1;
madot=280*pa1*M/R/T;
disp(madot,"mass flow rate in kg/min");
omega1=0.622*pv1/pa1;
k=omega1-0.0076;
disp(k,"mwdot/madot is (kg/kg)");
Qcvdot=madot*((ha2-ha1)-omega1*hg1+omega2*hg2+(
    omega1-omega2)*hf2);
disp(Qcvdot,"heat flow rate in kJ/min");
clear()
```

Scilab code Exa 10.4 4

```
//example 10.4
clc; funcprot(0);
// Initialization of Variable
omega1=0.002;
mstdot=52;
madot=90;
omega2=omega1+mstdot/60/madot;
disp(omega2,"humidity ratio is ");
clear()
```

Scilab code Exa 10.5 5

```
//example 10.5
clc; funcprot(0);
// Initialization of Variable
T1=100;
```

```
T2=70;
cpa=0.24;
omega1=0.0045;//humidity
hg1=1105;
hg2=38.1;
hg2=1092;
hf=38.1;
p2=14.696;//lb/in^2
omega2=(cpa*(T1-T2)+omega1*(hg1-hf))/(hg2-hf);
mwdot=352.1*60*(omega2-omega1);
disp(mwdot,"mass flow rate in lb/h");
pv2=omega2*p2/(omega2+0.622);
phi2=pv2/0.36332;
disp(phi2*100,"relative humidity in %")
clear()
```

Scilab code Exa 10.6 6

```
//example 10.6
clc; funcprot(0);
// Initialization of Variable
omega1=0.002;
omega2=0.0094;
ma1dot=180.0;
ma2dot=497.0;
omega3=(omega1*ma1dot+omega2*ma2dot)/(ma1dot+ma2dot)
    ;
disp(omega3,"relative humidity");
k1=10;//(ha+whv)1
k2=47.8;//(ha+whv)2
k3=(ma1dot*k1+ma2dot*k2)/(ma1dot+ma2dot)
disp(k3,"(ha+whv)3 in kJ/kg");
disp(19,"temperature by inspection in degreeC")
clear()
```

Scilab code Exa 10.7 7

```
//example 10.7
clc; funcprot(0);
// Initialization of Variable
m1dot=4.5e7;
hf1=159.21;
hf2=125.79;
ha4=308.2;
ha3=298.2;
w4=0.0327;//humidity
hg4=2565.3;
hg3=2547.2;
w3=0.0068;//humidity
hf5=83.96;
madot=m1dot*(hf1-hf2)/(ha4-ha3+w4*hg4-w3*hg3-(w4-w3)
   *hf5);
m5dot=madot*(w4-w3);
disp(m5dot,"mass flow rate in kg/h");
clear()
```

Chapter 11

Getting Started in Fluid Mechanics

Scilab code Exa 11.1 1

```
//example 11.1
clc; funcprot(0);
// Initialization of Variable
gas=42.5;//gamma of gasoline
hgas=17.0;//height of gasoline
hw=3.0;//height of water
wat=62.4;//gamma of water
k=gas*hgas/144.0;//p1-p0
disp(k,"pressure difference in lbf/in^2");
disp(k*144/wat,"pressure difference in feet of water
    ");
k1=wat*hw/144.0+k;//p2-p0
disp(k1*144,"pressure difference in lbf/ft^2");
disp(k1,"pressure difference in lbf/in^2");
disp(k1*144/wat,"pressure difference in feet of
    water");
clear()
```

Scilab code Exa 11.2 2

```
//example 11.2
clc; funcprot(0);
// Initialization of Variable
SGoil=0.9;//specific gravity of oil
wat=62.4;//gamma of water
SGhg=13.6;//specific gravity of mercury
h1=36.0/12;
h2=6.0/12;
h3=9.0/12;
pair=-SGoil*wat*(h1+h2)+SGhg*wat*h3;
pgage=pair/144.0;
disp(pgage,"Gauge pressure in lbf/in^2(psi)");
clear()
```

Scilab code Exa 11.3 3

```
//example 11.3
clc; funcprot(0);
// Initialization of Variable
b=2.0;
a=4.0;
gamm=9.8*10^3;//gamma
pi=3.14;
Fr=integrate('gamm*sin(pi*60/180)*b*y','y',6,10);
yr=gamm*sin(pi*60/180)/Fr*b*integrate('y^2','y'
    ,6,10);
disp(yr,"location of resultant weight in m");
//alternatively
yr1=b*a^3/12/b/a/8+8;
disp(yr1,"location of resultant weight in m");
```

```
clear()
```

Chapter 12

The Momentum and Mechanical Energy Equations

Scilab code Exa 12.1 1

```
//example 12.1
clc; funcprot(0);
// Initialization of Variable
//for a sample value of theta=45degrees
pi=3.14;
rho=1.94;
A=0.06;//area
V=10.0;//velocity
theta=pi*45/180;
Fax=-rho*A*V^2*(1-cos(theta));
disp(Fax,"resultant force in x direction in lbf");
Fay=rho*A*V^2*sin(theta);
disp(Fay,"resultant force in y direction in lbf");
clear()
```

Scilab code Exa 12.2 2

```
//example 12.2
clc; funcprot(0);
// Initialization of Variable
rho=1.94;
A=0.1;
V=50;
p1=30;//pressure
p2=24;//pressure
mdot=rho*A*V;
Fay=-2*mdot*V-(p1+p2)*144*A;
disp(Fay,"resultant force in y direction in lbf");
disp("resultant force in -ve y direction")
clear()
```

Scilab code Exa 12.3 3

```
//example 12.3
clc; funcprot(0);
// Initialization of Variable
pi=3.14;
rho=999.0;
Q=0.6/1000;
A1=pi*0.016^2/4;
A2=pi*0.005^2/4;
p1=464*1000;
p2=0;
Ww=0.03;
Wn=1;
mdot=rho*Q;
V1=Q/A1;
V2=Q/A2;
Fa=mdot*(V1-V2)+Wn+Ww+p1*A1;
disp(Fa,"Force in N");
clear()
```

Scilab code Exa 12.5 5

```
//example 12.5
clc; funcprot(0);
// Initialization of Variable
k=3.0;//p1/gamma
k2=0.5;//p2/gamma
z1=0;
z2=2;
hl=k-k2-z2+z1;
disp(hl,"head loss in terms of height of water")
clear()
```

Scilab code Exa 12.6 6

```
//example 12.6
clc; funcprot(0);
// Initialization of Variable
z1=100;
V2=6;
g=9.81;
gamm=9.8*1000;//density
Q=4.72;//flow rate
ht=z1-V2^2/2/g;
Wtdot=gamm*Q*ht/1000;
disp(Wtdot,"power output in kW");
clear()
```

Scilab code Exa 12.7 7

```
//example 12.7
clc; funcprot(0);
// Initialization of Variable
Wpdot=10*550;
gamm=62.4;//density
Q=2;//flow rate
hp=Wpdot/gamm/Q;
hl=-30+hp;
disp(hl,"head loss in ft");
Wdot=gamm*Q*hl/550;
disp(Wdot,"power output in hp");
clear()
```

Scilab code Exa 12.8 8

```
//example 12.8
clc; funcprot(0);
// Initialization of Variable
k=1.4;
p0=1*10^6;
p2=7.84*10^5;
k=1.4;
R=8314;//gas constant
T2=336;//temperature
M2=(2/(k-1)*((p0/p2)^((k-1)/k)-1))^0.5;
disp(M2,"the exit mach no is");
V2=M2*sqroot(k*R/28.97*T2);
mdot=p2*V2/1000/R/T2*28.97;
disp(mdot,"mass flow rate in kg/s");
clear()
```

Scilab code Exa 12.9 9

```
//example 12.9
clc; funcprot(0);
// Initialization of Variable
k1=0.88;//p2/poy;
k2=0.628;//poy/pox
pox=100;//pressure
R=1545;
T2=494;
k=1.4;
M2=0.24;
A=2.4;
V2=M2*sqroot(k*R/28.97*T2*32.2);
mdot=95.9*A*V2/T2/R*28.97;
disp(mdot,"mass flow rate in lb/s");
p2=k1*k2*pox;
disp(p2,"pressure in lbf/in^2")
clear()
```

Chapter 14

Internal and External Flow

Scilab code Exa 14.1 1

```
//example 14.1
clc; funcprot(0);
// Initialization of Variable
rho=1.23;//density
V=50;//velocity
D=0.004;//diameter
l=0.1;
mu=1.79e-5;
Re=rho*V*D/mu;
disp(Re,"reynolds no");
f=0.028;//friction factor from Moody's chart
delP=f*l/D*.5*rho*V^2/1000.0;
disp(delP,"pressure diffference in kPa");
clear()
```

Scilab code Exa 14.2 2

```
//example 14.2
```

```
clc; funcprot(0);
// Initialization of Variable
rho=1.94;
V=8.7;
D=0.0625;
g=32.2;
V2=19.6;
l=60;
z2=20;
mu=2.34e-5;
Kl=2;//constant
Re=rho*V*D/mu;
disp(Re,"reynolds no");
f=0.0215;//friction factor from Moody's chart
P1=rho*g*z2+1/2*rho*(V2^2-V^2)+rho*f*l/D*V^2/2;
P1=P1/144+rho*V^2/2*(10+4*1.5+Kl)/144;;
disp(P1,"entire pressure drop in psi");
clear()
```

Scilab code Exa 14.3 3

```
//example 14.3
clc; funcprot(0);
// Initialization of Variable
rho=1.67;
V=9.31;//velocity
D=4;
mu=8.0e-5;
g=32.2;
l=799;
Q=117;
f=0.0125;//friction factor
Re=rho*V*D/mu;
disp(Re,"reynolds no");
hp=f*l/D*V^2/2/g*5280;
```

```
disp(hp,"pump head in ft of H20");
hp=round(hp/100)*100
W=rho*g*Q*hp/550;
disp(W,"power required in hp");
clear()
```

Scilab code Exa 14.7 7

```
//example 14.7
clc; funcprot(0);
// Initialization of Variable
rho=0.00238;
U=80.7;//velocity
l=8;
mu=3.74e-7;
Cd=0.0066;
d=4;
Re=rho*U*l/mu;
disp(Re,"reynolds no");
f=0.0066;//friction factor from Moody's chart
D=1/2*rho*U^2*l*d*f;
disp(D,"drag force in lbf");
clear()
```

Scilab code Exa 14.8 8

```
//example 14.8
clc; funcprot(0);
// Initialization of Variable
rho=0.00238;
U=93.5;//velocity
Cd1=0.55;//coeff of drag
A1=5.2*5.1;
```

```
D1940=1/2*rho*Cd1*A1*U^2;
disp(D1940,"drag force in lbf");
A2=5.2*4.3;
Cd2=0.3;
D2003=1/2*rho*Cd2*A2*U^2;
disp(D2003,"drag force in lbf");
W1940=D1940*U/550;
disp(W1940,"power required to overcome drag force in
    hp");
W2003=D2003*U/550;
disp(W2003,"power required to overcome drag force in
    hp");
clear()
```

Scilab code Exa 14.9 9

```
//example 14.9
clc; funcprot(0);
// Initialization of Variable
A=96*7.5;
W=210;
rho=2.38e-3;
U=15;
Cl=2*W/rho/U^2/A;
disp(Cl,"coeff. of lift ");
clear()
```

Chapter 15

Getting Started in Heat Transfer

Scilab code Exa 15.1 1

```
//example 15.1
clc; funcprot(0);
// Initialization of Variable
k=1.7;
delT=250;
L=0.15;
H=0.5;
W=1.2;
qx=k*delT/L;
qx=H*W*qx;
disp(qx,"heat flux in W");
clear()
```

Scilab code Exa 15.2 2

```
//example 15.2
```

```
clc; funcprot(0);
// Initialization of Variable
Ts=473;
sigma=5.67e-8;
Tsur=298;
h=15.0;
pi=3.14;
D=0.07;
epsilon=0.8;//emmisivity
E=epsilon*sigma*Ts^4;
G=sigma*Tsur^4;
disp(G,"irradiation in W/m^2");
q=h*pi*D*(Ts-Tsur)+epsilon*pi*D*sigma*(Ts^4-Tsur^4);
disp(q,"heat transfer per unit length in W/m");
clear()
```

Scilab code Exa 15.5 5

```
//example 15.5
clc; funcprot(0);
// Initialization of Variable
k=1.2;
epsilon=0.8;//emmisivity
h=20;
Ts=373;
Tsur=298;
sigma=5.67e-8;
L=.15;//length
a=h*(Ts-Tsur)+epsilon*sigma*(Ts^4-Tsur^4);
T1=Ts+L/k*a;
disp(T1,"inner wall temperature in K");
disp(T1-273,"inner wall temperature in K")
clear()
```

Scilab code Exa 15.6 6

```
//example 15.6
clc; funcprot(0);
// Initialization of Variable
//solving for Ts
Tinfinity=293;
Tsurr=303;
epsilon=0.5;//emmisivity
alpha=0.8;
G=2000;
h=15;
sigma=5.67e-8;
deff('y=f(x)','y=alpha*G-h*(x-Tinfinity)-epsilon*
    sigma*(x^4-Tsurr^4)');
[x]=fsolve(307,f);
disp(x,"temperature in K");
disp(x-273,"temperature in degree C");
clear()
```

Chapter 16

Heat Transfer by Conduction

Scilab code Exa 16.1 1

```
//example 16.1
clc; funcprot(0);
// Initialization of Variable
Tso=50;//temperature
Tinfinity=25;//temperature
Tsi=385;//temperature
ka=0.15;
kb=0.08;
ho=25;//W/K/m^2
La=(Tsi-Tso)/(1/ka+0.5/kb)/(ho*(Tso-Tinfinity));
L=La+0.5*La
disp(L*1000,"required thickness of composite in mm")
    ;
clear()
```

Scilab code Exa 16.2 2

```
//example 16.2
```

```
clc; funcprot(0);
// Initialization of Variable
h=100;
Tinfinity=25;
Pe=10^4;
Tc=Tinfinity+Pe*(1/(1/h)+1/(0.9e-4+0.008/238+1/h))^-1;
disp(Tc,"allowable maximum temperature in degreeC")
clear()
```

Scilab code Exa 16.3 3

```
//example 16.3
clc; funcprot(0);
// Initialization of Variable
r1=0.25;//m
r2=0.275;//m
T1=300;
T2=77;
k=0.0017;
hfg=2.0e5;
pi=3.14;
q=(T1-T2)/(1/4/pi/k*(1/r1-1/r2)+1/20/4/pi/r2^2);
disp(q,"heat transfer in W");
mdot=q/hfg;
k=mdot/804*1000*3600*24;
disp(k,"mdot/rho in liters/day")
clear()
```

Scilab code Exa 16.4 4

```
//example 16.4
clc; funcprot(0);
```

```
// Initialization of Variable
Tinfinity=30;
q=1.5e6;
La=0.05;
h=1000;
T2=Tinfinity+q*La/h;
disp(T2,"temperature in degreeC");
T1=Tinfinity+(0.02/150+1/h)*q*La;
To=q*La^2/2/75+T1;
disp(To,"inner surface temperature in degreeC");
clear()
```

Scilab code Exa 16.6 6

```
//example 16.6
clc; funcprot(0);
// Initialization of Variable
pi=3.14;
h=100; //W/m^2/K
P=pi*0.005;
k=398;
Ac=pi/4*0.005^2;
thetab=100-25;
qf=(h*P*k*Ac)^0.5*thetab;
disp(qf,"heat rate in copper rod in W");
L=2.65*(k*Ac/h/P)^0.5*1000;
disp(L,"minimum value of the length in mm");
clear()
```

Scilab code Exa 16.7 7

```
//example 16.7
clc; funcprot(0);
```

```
// Initialization of Variable
pi=3.14;
T1=80;
Tinfinity=20;//temperature
Rtc1=1e-3;//m2K/W
r1=0.002;
r2=0.003;
H=0.006;
k=200;
Rtb=638;//K/W
Rtf12=24.4;
Rtc=Rtc1/2/pi/r1/H;
Rtsleeve=log(r2/r1)/2/pi/H/k;
Requiv=(1/Rtf12+1/Rtb)^-1;
Rtot=Rtc+Rtsleeve+Requiv;
qt=(T1-Tinfinity)/Rtot
disp(qt,"heat transfer rate in W");
clear()
```

Scilab code Exa 16.8 8

```
//example 16.8
clc; funcprot(0);
// Initialization of Variable
D=0.125;
h=25;//W/m^2
k=1.4;
c=835;//J/kg
Tinfinity=20;//degreeC
Ti=225;//degreeC
t=360;
rho=2225;//density
Lc=D/6;
Tt=Tinfinity+(Ti-Tinfinity)*exp(-h*t/rho/Lc/c);
disp(Tt,"temperature after 6 min in degreeC");
```

```
clear()
```

Scilab code Exa 16.9 9

```
//example 16.9
clc; funcprot(0);
// Initialization of Variable
rho=2770;
L=0.0015;
epsilon=0.8;//emmisivity
Tavg=360.5;
Tsur=448;
sigma=5.67e-8;
c=875;//J/kg-K
tc=rho*L*c/(40+12)*log((25-175)/(150-175));
te=tc+5*60;
disp(te,"total time spent in s");
hrad=epsilon*sigma*(Tavg+Tsur)*(Tavg^2+Tsur^2);
disp(hrad,"radiation energy in W/m^2-K");
clear()
```

Scilab code Exa 16.10 10

```
//example 16.10
clc; funcprot(0);
// Initialization of Variable
h=100;//W/m^2
L=0.025;
c=800;
rho=2325;//density
k=1.0;
Tinfinity=175;
Ti=25;
```

```
alpha=5.38e-7;
t=60*10;
theta=0.615;
Bi=h*L/k;
disp(Bi,"Biot number is");
Fo=alpha*t/L^2;
disp(Fo,"Fourier number is");
T10=Tinfinity+theta*(Ti-Tinfinity);
disp(T10,"midplane temperature after 10 min degreeC");
tstar=theta*cos(1.1347);
Tl10=Tinfinity+tstar*(Ti-Tinfinity);
disp(T10,"msurface temperature after 10 min degreeC");
ql=h*(Tl10-Tinfinity);
disp(ql,"heat transfer in W/m^2");
Q=rho*c*0.509*L*(Ti-Tinfinity);
disp(Q,"Energy per unit surface in J/m^2")
clear()
```

Chapter 17

Heat transfer by Convection

Scilab code Exa 17.1 1

```
//example 17.1
clc; funcprot(0);
// Initialization of Variable
k=integrate('x^-0.1','x',0,1);
disp(k,"ratio of average convection coefficient");
clear()
```

Scilab code Exa 17.2 2

```
//example 17.2
clc; funcprot(0);
// Initialization of Variable
U=10;//m/s
L=0.5;
nu=30.84e-6;
Pr=0.687;//prandtl number
Re=U*L/nu;
disp(Re,"reynolds number");
```

```
Nul=0.664*Re^0.5*Pr^0.33;
h=Nul*0.0364/L;
q=h*L*(300-27);
disp(q,"colling rate in W/m");
//if there is turbulence
Nul=0.037*Re^0.8*Pr^0.33;
h1=Nul*0.0364/L;
q1=h1*L*(300-27);
disp(q1,"colling rate in W/m in turbulence");
clear()
```

Scilab code Exa 17.3 3

```
//example 17.3
clc; funcprot(0);
// Initialization of Variable
u=60;//m/s
Nu5=546;
nu=26.41e-6;
L4=0.2;
L5=0.25;
Pr=0.69;
Re4=u*L4/nu;
Re5=u*L5/nu;
Nu4=0.664*Re4^0.5*Pr^0.33;
h14=Nu4*0.0338/L4;
Nu4=0.664*Re5^0.5*Pr^0.33;
h15=Nu5*0.0338/L5;
qconv=(h15*L5-h14*L4)*(230-25);
disp(qconv,"heat transfer rate in W");
clear()
```

Scilab code Exa 17.4 4

```
//example 17.4
clc; funcprot(0);
// Initialization of Variable
pi=3.14;
Ts=128.4;
Tinfinity=26.2;
k=0.03;
D=0.0127;//m
Re=6071;//reynold's no
Pr=0.7;
qconv=46;
A=pi*0.0127*0.094;
h=0.85*qconv/A/(Ts-Tinfinity);
disp(h,"heat transfer coefficient in W/m^2-K");
Nu=0.3+0.62*Re^0.5*Pr^0.33/(1+0.4^0.66*Pr^0.66)^0.25*(1+(Re/282000)^0.625)^0.8;
hbar=Nu*k/D;
disp(Nu,"Nusselt no is")
disp(hbar,"heat transfer coefficient in W/m^2-K");
//using Hilpert correlation
Nu1=0.193*Re^0.618*Pr^0.333;
disp(Nu1,"Nusselt no is");
hbar1=Nu1*k/D;
disp(hbar1,"heat transfer coefficient in W/m^2-K");
clear()
```

Scilab code Exa 17.5 [5]

```
//example 17.5
clc; funcprot(0);
// Initialization of Variable
Ti=75;
k=0.02588;
D=0.01;
Nu=47.4
```

```
rho=8933;//density
c=387;
D=0.01;
Tinfinity=23;
T=35;
h=Nu*k/D;
t=rho*c*D/6/h*log((Ti-Tinfinity)/(T-Tinfinity));
disp(t,"cooling time required in s");
Bi=h*0.005/3/399;
disp(Bi,"Biots number")
clear()
```

Scilab code Exa 17.6 6

```
//example 17.6
clc; funcprot(0);
// Initialization of Variable
m=0.1;
cp=4179;//J/kg/K
q=10^6;//W/m^3
Do=0.04;
Di=0.02;
pi=3.14;
L=4*m*cp/(Do^2-Di^2)/pi/q*(60-20);
disp(L,"tube length in m");
Re=4*m/pi/Di/6.57e-4;
disp(Re,"reynolds number");
qs=q*(Do^2-Di^2)/4/Di;
ho=qs/(70-60);
disp(ho,"local heat coefficient in W/m^2-K");
clear()
```

Scilab code Exa 17.7 7

```
//example 17.7
clc; funcprot(0);
// Initialization of Variable
m=0.25;//kg/s
cp=4178;//J/kg-K
Tmo=57;
Tmi=15;
pi=3.14;
D=0.05;//m
L=6;//m
delT=(-Tmo+Tmi)/log((100-Tmo)/(100-Tmi));
h=m*cp/pi/D/L*(Tmo-Tmi)/delT;
disp(h,"average convection coefficient in W/m^2-K");
clear()
```

Scilab code Exa 17.9 9

```
//example 17.9
clc; funcprot(0);
// Initialization of Variable
pi=3.14;
qs=2000;
cp=4181;
m=0.01;
D=0.06;
k=0.67;
Nu=4.36;
L=m*cp/pi/0.06/qs*(80-20);
disp(L,"tube length in m");
h=Nu*k/D;
Ts=qs/h+80;
disp(Ts,"surface temperature in degreeC");
clear()
```

Scilab code Exa 17.10 10

```
//example 17.10
clc; funcprot(0);
// Initialization of Variable
m=2;//kg/s
D=0.04;//m
mu=695*10^-6;//Ns/m^2;
pi=3.14;
Nu=396;//nusselt number
Re=4*m/pi/D/mu;
disp(Re,"reynolds number");
h=Nu*0.628/D;
Tmo=95-(95-25)*exp(-pi*D*h/m/4178*4);
disp(Tmo,"temperature in degree c");
q=m*4176*(Tmo-25);
disp(q/1000,"rate of heat transfer in kW");
Nu1=0.027*Re^0.8*4.62^0.33;
disp(Nu1,"Nusselt number");
h1=Nu1*0628/D;
disp(h1/1000,"coefficient of heat transfer in W/m-K"
  );
clear()
clear()
```

Scilab code Exa 17.11 11

```
//example 17.11
clc; funcprot(0);
// Initialization of Variable
k=33.8e-3;
L=0.71;
```

```
A=1.02*0.71;//area
Ts=505;//temperature
Tsur=296//temperature
Nu=147;
h=Nu*k/L;
q=h*A*(Ts-Tsur);
disp(q,"heat transfer by convection in W");
qrad=A*5.67e-8*(Ts^4-Tsur^4);
disp(qrad,"heat transfer by radiation in W");
hrad=5.67e-8*(Ts+Tsur)*(Ts^2+Tsur^2);
disp(hrad,"linearized radiation coffecient in W/m^2-
    K");
clear()
```

Scilab code Exa 17.12 12

```
//example 17.12
clc; funcprot(0);
// Initialization of Variable
Nu=65.8;
k=0.028;
As=1.2*1.2;//area
Ts=350;//temperature
Tsurr=300;//temperature
sigma=5.67e-8;
epsilon=0.25;//emmisivity
h=Nu*k/0.3;
Pe=h*As*(Ts-Tsurr)+epsilon*sigma*As*(Ts^4-Tsurr^4);
disp(Pe,"allowable electrical power in W");
clear()
```

Scilab code Exa 17.13 13

```
//example 17.13
clc; funcprot(0);
// Initialization of Variable
pi=3.14;
D=0.1;
Nu=23.3;
k=0.0313;
Ts=438;//temperature
Tsurr=296;//temperature
sigma=5.67e-8;
epsilon=0.85;//emmisivity
h=Nu*k/D;
q=h*pi*D*(Ts-Tsurr)+epsilon*sigma*pi*D*(Ts^4-Tsurr
    ^4);
disp(q,"heat transfer rate from the pipe in W/m");
clear()
```

Scilab code Exa 17.14 14

```
//example 17.14
clc; funcprot(0);
// Initialization of Variable
pi=3.14;
k=0.625;
D=0.025;
Nu=90;
ho=40;
q=8524;
delT=(59.8-30)/log(59.8/30);
hi=Nu*k/D;
U=1/(1/hi+1/ho);
L=q/(U*pi*D*delT);
disp(L,"length of exchanger in m");
clear()
```

Scilab code Exa 17.15 15

```
//example 17.15
clc; funcprot(0);
// Initialization of Variable
pi=3.14;
q=7.317e5;
c=2350;
Thi=160;
Thd=100;
delT=(75-85)/log(75/85);
mh=q/c/(Thi-Thd);
disp(mh,"mass flow rate of oil in kg/s");
ho=400;
k=0.643;
D=0.025;//diameter
Nu=119;
hi=k/D*Nu;
U=1/(1/hi+1/ho);
L=q/(U*pi*D*delT*10*0.87);
disp(L,"length of exchanger in m");
clear()
```

Chapter 18

Heat transfer by radiation

Scilab code Exa 18.1 1

```
//example 18.1
clc; funcprot(0);
// Initialization of Variable
G1=600;//G1=Glambda
alpha=0.85;
G=G1*(2.5-1)*0.5+G1*0.5*(0.5)+G1*(1.0-0.5);
disp(G,"total radiation in W/m^2");
Gabs=alpha*G;
disp(Gabs,"absorbed radiation in W/m^2");
J=0.15*G+525;
disp(J,"total radiosity");
qrad=525-Gabs;
disp(qrad,"net radiative flux leaving the surface in
    W/m^2");
clear()
```

Scilab code Exa 18.2 2

```
//example 18.2
clc; funcprot(0);
// Initialization of Variable
sigma=5.67e-8;
lambda1=2200;//mum
T=2000;//K
C1=3.742e8;//mum^4/m^2
C2=1.439e8;
lambdamax=1.45;//mum
E=sigma*T^4;
disp(E,"spectral emmisive power in W/m^2");
lambda=lambda1/T;
disp(lambda,"wavelength corresponding to upper limit in mum");
E=C1/lambdamax^5/(exp(C2/lambdamax/T)-1);
disp(E,"emissive power in W/m^2.mum");
disp("G=9.07*10^5 in W/m^2");
clear()
```

Scilab code Exa 18.4 4

```
//example 18.4
clc; funcprot(0);
// Initialization of Variable
F1=0.318;//F0---2 mum
F2=0.856;//F0---5 mum
sigma=5.67e-8;
T=1600;//kelvin
epsilon=0.4*F1+0.8*(F2-F1);
disp(epsilon,"emmisivity");
E=epsilon*sigma*T^4;
disp(E/1000,"total emmisive power in kW/m^2");
clear()
```

Scilab code Exa 18.5 5

```
//example 18.5
clc; funcprot(0);
// Initialization of Variable
F=0.738;//F0——l1 ' mum
F1=0.014;//F0——l1 mum
sigma=5.67e-8;
Ts=300;
Tf=1200;
alpha=0.8*F+0.1*(1-F);
disp(alpha,"total absorvity")
epsilon=0.8*F1+0.1*(1-F1);
disp(epsilon,"emmisivity");
qrad=epsilon*sigma*Ts^4-alpha*sigma*Tf^4;
disp(qrad/1000,"total emissice power in kW/m^2");
disp("epsilon=alpha=0.62 for final condition");
clear()
```

Scilab code Exa 18.6 6

```
//example 18.6
clc; funcprot(0);
// Initialization of Variable
plambda=0.05;
sigma=5.67e-8;
T=300;//K
epsilon=1-plambda;
qrad=epsilon*sigma*T^4-0.226*1353;
disp(qrad,"net radiative heat flux leaving in W/m^2"
  );
clear()
```

Scilab code Exa 18.7 7

```
//example 18.7
clc; funcprot(0);
// Initialization of Variable
pi=3.14;
F12=0.5;
A1=4;//area in terms of L
A2=2*pi/4;//area in terms of L
F21=A1/A2*F12;
disp(F21,"reciprocity relation between A1 and A2");
//part2
F12=1;
A1=1/16;//area in terms of D
A2=1/2;//area in terms of D
F21=A1/A2*F12;
disp(F21,"reciprocity relation between A1 and A2");
//part3
F22=0.5;
F23=1-F21-F22;
disp(F23,"reciprocity relation");
//part4
F13=0.17;
F12=1-F13;
A1=1/4;//area in terms of D
A2=1;//area in terms of D
F21=A1/A2*F12;
disp(F21,"reciprocity relation between A1 and A2");
clear()
```

Scilab code Exa 18.8 8

```
//example 18.8
clc; funcprot(0);
// Initialization of Variable
pi=3.14;
sigma=5.67e-8;
T1=1623//K
T2=1923;//K
T3=300;//K
F23=0.06;
A2=pi*0.075^2/4;
A1=pi*0.075*0.15;
F21=1-F23;
F12=A2/A1*F21;
Pe=A1*0.118*sigma*(T1^4-T3^4)+A2*F23*sigma*(T2^4-T3^4);
disp(Pe,"Electrical power required in W");
clear()
```

Scilab code Exa 18.9 9

```
//example 18.9
clc; funcprot(0);
// Initialization of Variable
sigma=5.67e-8;
D1=0.02;
D2=0.05;
D3=0.035;
pi=3.14;
T1=77;
T2=300;
qwo=(sigma*pi*D1*(T1^4-T2^4))/(1/0.02+(1-0.05)/0.05*(D1/D2));
disp(qwo,"heat rate per unit length in W/m");
Rtot=(1-0.02)/(0.02*pi*D1)+1/pi/D1+2*(1-0.02/(0.02*pi*D3)+1/pi/0.035+(1-0.05)/pi/D2^2);
```

```
qw=sigma*(T1^4-T2^4)/1817;
disp(qw,"heat rate of radiation in W/m");
k=(qw-qwo)/qwo*100;
disp(k,"percentage change of heat transfer in %");
clear()
```

Scilab code Exa 18.10 10

```
//example 18.10
clc; funcprot(0);
// Initialization of Variable
e1=0.8;
e2=0.4;
T1=1200;
T2=500;
A=1;
Jr=(108323+59043)/2;
sigma=5.67e-8;
q1=sigma*(T1^4-T2^4)/((1-e1/e1/A)+1/(A*0.5+(2+2)^-1)
    +(1-e2)/e2/A);
disp(q1/1000,"the rate of energy supply in kW/m");

Tr=(Jr/sigma)^0.25;
disp(Tr,"temperature in radiating surface in K");
clear()
```