Scilab Textbook Companion for Elements of Mechanical Engineering by N. M. Bhatt and J. R. Mehta[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

Chapter 1

Introduction

Scilab code Exa 1.1.1 Example1

```
1 clc
2 clear
3
4 //Solving the problem
5 Q=84-8.4-21+4.2;
6 printf('The Net Work Done= %2.1f kJ',Q);      //
    Displaying result
```

Scilab code Exa 1.1.2 Example2

```
1 clc
2 clear
3
4 //Declaring values
5 Q=-700;
6 W=-3000;
7 m=5;
8 U=Q-W;
```

```
Us=U/m;
printf('Change in Specific Energy= %3.0f J/kg',Us);
      //displaying result
```

Scilab code Exa 1.1.3 Example3

```
clc
clear

//Declaring values
Q=50;
W=40;
U=Q-W;
printf('Change in Internal Energy= %2.0f kJ',U);
```

Scilab code Exa 1.1.4 Example4

```
clc
clear

m=3000;       //mass in kg
P=736;        //Power in kW
t=5*3600;     //Time in seconds
HV=27170      //Heating value in kJ/kg

E=P/((m/t)*HV);
Eff=E*100;
printf('Thermal Efficiency= %2.2f percent',Eff);
```

Scilab code Exa 1.1.5 Example5

```
clc
clear

U=22;        //Internal Energy in kJ/s
P2=0.95*1000;    //Pressure in kPa
V2=0.09;         //Volume in m^3/s;
P1=0.5*1000;
V1=0.15;
X=(P2*V2)-(P1*V1);
H=U+X;

printf('Change in Enthalpy: %2.1f kJ/s',H);
```

Scilab code Exa 1.1.6 Example6

```
clc
clear

Th=0.22;         //Thermal Efficiency
Hr=1260;         //Heat Rejected in MJ/hr
CV=42;           //Calorific Value of Coal
X=1-Th;
HI=Hr/X;         //Heat Input in MJ/hr

O=((HI-Hr)*1000)/3600;          //Output
Mf=HI/CV;        //Mass of Fuel Used

printf('Power Output is %2.2f kW',O);
printf('\n');
printf('Mass of Fuel used per hour: %2.1f kg/hr',Mf)
   ;
```

Scilab code Exa 1.1.7 Example7

```
clc
clear

m=2;          //mass in kg
T1=30+273;    //Temperature in K
T2=60+273;
Cp=4.187;
T=T2/T1;
X=double(log(T));
S=m*Cp*X;
printf('Entropy Change of Water: %1.4f kJ/K',S);
```

Scilab code Exa 1.1.8 Example8

```
clc
clear

//Declaring Values
m=600;            //Mass in kg
z=50000;          //Distance in meters
V=2500000;        //Velocity in m/hr
g=7.9;            //Gravitational Field in m/s^2
Vel=V/3600;
KE=(0.5*m*Vel*Vel)/1000000;    //Kinetic Energy in MJ
PE=(m*g*z)/1000000;                    //Potential
   Energy in MJ

//Displaying Results
printf('The Kinetic Energy is %3.2f MJ',KE);
printf('\n')
printf('The Potential Energy is %3.2f MJ',PE);
```

Chapter 3

Properties of Gases

Scilab code Exa 3.1.1 Example1

```
clc
clear

//Declaring Values
V=3;          //Volume in m^3
P1=2500;        //Pressure in kilobar
P2=1500;
T2=21+273;   //Temperature in Kelvin
T1=(T2*P1)/P2;
Cp=1.005;
Cv=0.718;
R=Cp-Cv;              //Universal Gas Constant
m=(P1*V)/(R*T1);          //Calculating mass
H=m*Cp*(T2-T1);
U=m*Cv*(T2-T1);
Q=U;          //Since Constant Volume Process: Work
   Done=0
//Displaying Results
printf('Change in Enthalpy: %5.2f kJ',H);
printf('\n');
printf('Change in Internal Energy: %5.2f kJ',U);
```

```
21 printf('\n');
22 printf('Heat Transfer: %4.2f kJ',Q);
23 printf('\n')
24 printf('As Answer is negative, system rejects heat')
   ;
```

Scilab code Exa 3.2.1 Example2

```
1  clc
2  clear
3
4  //Inputs
5  m=1;          //Mass in kg
6  P1=7;          //Pressure in bar
7  T1=90+273;    //Temperature in K
8  P2=1.4;
9  R=0.287;
10 G=1.4;        //Gamma for air
11 //Calculations according to data required
12 x=P2/P1;
13 y=0.1/1.1;
14 z=x^y;
15 T2=T1*z;          //calculating T2
16 printf('Final Temperature is: %3.1f K',T2);
17 printf('\n');
18 W=(m*R*(T1-T2))/(1.1-1);
19 printf('Work Done is: %3.1f kJ',W);
20 printf('\n');
21 Cv=(R)/(G-1);
22 Cp=R+Cv;
23 CI=m*Cv*(T2-T1);
24 printf('Change in Internal Energy is: %3.2f kJ',CI);
25 printf('\n');
26 Q=CI+W;
27 printf('Heat Transfer is: %3.2f kJ',Q);
```

```
28 printf('\n');
```

Scilab code Exa 3.3.1 Example3

```
1  clear
2  clc
3
4  P1=2.75*100;          //Pressure in kPa
5  V1=0.09              //Volume in m^3
6  T1=185+273;          //Temperature in Kelvin
7  T2=15+273;
8  R=0.29;
9  Cp=1.005;
10 Cv=0.715;
11
12 m=(P1*V1)/(R*T1);
13 V2=(T2/T1)*V1;
14 W=P1*(V2-V1);
15 printf('The Work Done: %2.3f kJ',W);
16 printf('\n');
17 Q=m*Cp*(T2-T1);
18 printf('The Heat Transfer: %2.3f kJ',Q);
19 printf('\n');
20 U=Q-W;
21 printf('The change in Internal Energy: %2.3f kJ',U);
22 printf('\n');
```

Scilab code Exa 3.4.1 Example4

```
1 clc
2 clear
3
4 //Inputs
```

```
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
     adding 273)
7 //Pressure in bar converted to kPa (by multiplying
     100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10
11 m=0.67;
12 P1=14;
13 T1=290+273;
14 R=287;
15 V1=(m*R*T1)/(14*(10^5));
16 printf('The Volume: %2.3f kJ',V1);
17 printf('\n');
18 V2=4*V1;
19 printf('The Final Volume: %2.3f kJ',V2);
20 printf('\n');
21 x=V1/V2;
22 y=x^1.3;
23 P2=P1*y;
24 printf('The Final Pressure: %2.3f bar',P2);
25 printf('\n');
26 x=V1/V2;
27 y=x^0.3;
28 T2=T1*y;
29 printf('The Final Temperature: %2.3f K',T2);
30 printf('\n');
```

Scilab code Exa 3.5.1 Example5

```
1 clc
2 clear
3
4
```

```
5 //Inputs
6 //The Values in the program are as follows:
7 //Temperature in Celcius converted to Kelvin(by
     adding 273)
8 //Pressure in bar converted to kPa (by multiplying
     100)
9 //Volume in m^3
10 //Value of R,Cp and Cv in kJ/kg K
11 P1=510;
12 V1=0.142;
13 P2=170;
14 V2=0.275;
15 H=-65;
16 Cv=0.718;
17 X=(P2*V2)-(P1*V1);
18 U=H-X;
19 printf('The Change in Internal Energy: %2.2f kJ',U);
20 printf('\n');
21 G=H/U;
22 Cp=G*Cv;
23 R=Cp-Cv;
24 printf('The Value of R: %2.3f kJ/kg K',R);
25 printf('\n');
```

Scilab code Exa 3.6.1 Example6

```
1 clc
2 clear
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
     adding 273)
7 //Pressure in bar converted to kPa (by multiplying
     100)
```

```
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10 P1=25;
11 T1=27+273;
12 P2=5;
13 T2=20+273;
14 V1=0.7;
15 Et=1.43;
16 Pn=101.325;
17 Tn=273;
18
19 //Calculations
20 R=(Pn)/(Et*Tn);
21 m1=(Pn*V1)/(R*Tn);
22 V2=(m1*R*T1)/(P1*100);
23 m2=(P2*100*V2)/(R*T2);
24 mf=m1-m2;
25 printf('The mass of Oxygen used: %3.3f kg',mf);
26 printf('\n');
```

Scilab code Exa 3.7.1 Example7

```
1 clc
2 clear
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
    adding 273)
7 //Pressure in bar converted to kPa (by multiplying
    100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10 n=1.3;
11 m=1;
```

```
12 T1=300;
13 T2=200;
14 W=90;
15 Ro=8.3143;
16 R=((n-m)*W)/((T1-T2)*m);
17 M=Ro/R;
18 printf('The molecular mass of gas is: %3.1f kg/kg
      mole',M);
19 printf('\n');
```

Scilab code Exa 3.8.1 Example8

```
1  clc
2  clear
3
4  //Inputs
5  //The Values in the program are as follows:
6  //Temperature in Celcius converted to Kelvin(by
      adding 273)
7  //Pressure in bar converted to kPa (by multiplying
      100)
8  //Volume in m^3
9  //Value of R,Cp and Cv in kJ/kg K
10 m=0.18;
11 V1=0.15;
12 T1=15+273;
13 P1=100;
14 V2=0.056;
15 P2=400;
16 R=(P1*V1)/(m*T1);
17 printf('The Gas Constant: %3.3f kJ/kg K',R);
18 printf('\n');
19 M=8.3141/R;
20 printf('The Molecular Mass of Gas: %3.2f kg/kg mole'
      ,M);
```

```
21 printf('\n');
22 x=log(P2/P1);
23 y=log(V2/V1);
24 G=-(x/y);
25 Cv=R/(G-1);
26 printf('The Cv: %3.2f kJ/kg K',Cv);
27 printf('\n');
28 Cp=Cv+R;
29 printf('The Cp: %3.2f kJ/kg K',Cp);
30 printf('\n');
31 x=(G-1)/G;
32 y=P2/P1;
33 z=y^x;
34 T2=T1*z;
35 U=m*Cv*(T2-T1);
36 printf('The change in Internal Energy: %3.2f kJ',U);
37 printf('\n');
```

Scilab code Exa 3.9.1 Example9

```
1 clc
2 clear
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
    adding 273)
7 //Pressure in bar converted to kPa (by multiplying
    100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10 P1=100;
11 V1=0.25;
12 T1=100+273;
13 V2=0.05;
```

```
14 P2=750;
15 G=1.4;
16 R=0.298;
17 n=(log(P2/P1))/(log(V1/V2));
18 printf('The Index n: %1.2f ',n);
19 printf('\n');
20 T2=T1*((P2/P1)^((n-1)/n));
21 Cv=R/(G-1);
22 Cp=R+Cv;
23 m=(P1*V1)/(R*T1);
24 W=(m*R*(T1-T2))/(n-1);
25 Q=((G-n)/(G-1))*W;
26 printf('The Heat change: %2.2f kJ',Q);
27 printf('\n');
28 U=m*Cv*(T2-T1);
29 printf('The change in Internal Energy: %2.2f kJ',U);
30 printf('\n');
```

Scilab code Exa 3.13.1 Example13

```
1 clc
2 clear
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
    adding 273)
7 //Pressure in bar converted to kPa (by multiplying
    100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10 m=1;
11 P2=25;
12 P1=1;
13 pV=260;
```

```
14 T1=17+273;
15 T2=T1;
16 V1=(pV*T1)/(P1*100000);
17 printf('As process is Isothermal, Initial and Final
     Temperatures are same \n');
18 printf('The Final Temperature: %3.0f K',T1);
19 printf('\n');
20 V2=(pV*T2)/(P2*100000);
21 printf('The Final Volume: %3.5f m^3',V2);
22 printf('\n');
23 CR=P2/P1;
24 printf('The Compression Ratio: %3.0f ',CR);
25 printf('\n');
26 printf('Change in Enthalpy is zero as it is
     Isothermal process \n');
27 W=P1*100*V1*(log(P1/P2));
28 printf('Work Done is: %3.1f kJ',W);
29 printf('\n');
```

Scilab code Exa 3.14.1 Example14

```
1 clc
2 clear
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
     adding 273)
7 //Pressure in bar converted to kPa (by multiplying
     100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10 P2=6;
11 Cp=1.75;
12 P1=1;
```

```
13 n=1.3;
14 T1=30+273;
15 M=30;
16 m=2;
17 Ro=8314.4;
18 R=(Ro/M)/1000;
19 printf('The Gas Constant: %3.3f kJ/kg K', R);
20 printf('\n');
21 Cv=Cp-R;
22 G=Cp/Cv;
23 printf('The value of Gamma: %1.2f ',G);
24 printf('\n');
25 T2=(T1)*((P2/P1)^((n-1)/n));
26 printf('Final Temperature: %3.2f K',T2);
27 printf('\n');
28 W=(m*R*(T1-T2))/(n-1);
29 printf('The work done on the gas: %3.2f kJ',W);
30 printf('\n');
31 Q=((G-n)/(G-1))*W;
32 printf('The Heat Transfer is %3.2f kJ',Q);
33 printf('\n');
34 U=m*Cv*(T2-T1);
35 printf('The change in Internal Energy is %3.2f kJ',U
   );
36 printf('\n');
```

Scilab code Exa 3.15.1 Example15

```
1 clc
2 clear
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
   adding 273)
```

```
7 //Pressure in bar converted to kPa (by multiplying
    100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10 P1=350;
11 P2=130;
12 R=0.287;
13 T1=450;
14 G=1.4;
15 m=1;
16 T2=T1*((P2/P1)^((G-1)/G));
17 W=(m*R*(T1-T2))/(G-1);
18 printf('Amount of External Work done: %3.2f kJ/kg',W
    );
19 printf('\n');
20 U=-W;
21 printf('Change in Internal Energy: %3.2f kJ/kg',U);
22 printf('\n');
```

Scilab code Exa 3.16.1 Example16

```
1 clc
2 clear
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
    adding 273)
7 //Pressure in bar converted to kPa (by multiplying
    100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10 P1=1.5;
11 V1=0.1;
12 V2=0.04;
```

```
13 P2=7.5;
14 T1=30+273;
15
16 //Using ideal gas equation
17 T2=(P2*V2*T1)/(P1*V1);
18 printf('The Value of Temperature of gas: %3.0f K',T2
   );
```

Scilab code Exa 3.17.1 Example17

```
1  clc
2  clear
3
4  //Inputs
5  //The Values in the program are as follows:
6  //Temperature in Celcius converted to Kelvin(by
      adding 273)
7  //Pressure in bar converted to kPa (by multiplying
      100)
8  //Volume in m^3
9  //Value of R,Cp and Cv in kJ/kg K
10 P1=1.5;
11 V1=3;
12 T1=27+273;
13 P2=30;
14 T2=60+273;
15 R=0.287;
16
17 m1=(P1*100*V1)/(R*T1);
18 m2=(P2*100*V1)/(R*T2);
19
20 m=m2-m1;
21 printf('The mass pumped: %2.2f kg',m);
22 printf('\n');
23 V=(m*R*(17+273))/(1*100);
```

```
24
25 printf('Volume: %2.2f m^3',V);
26 printf('\n');
27
28 T3=27+273;
29 P3=(T3*P2)/T2;
30
31 printf('Final air pressure in the vessel: %2.2f bar'
   ,P3);
32 printf('\n');
```

Scilab code Exa 3.18.1 Example18

```
1 clc
2 clear
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
   adding 273)
7 //Pressure in bar converted to kPa (by multiplying
   100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10 V1=1.5;
11 m=2;
12 T1=27+273;
13 T2=207+273;
14 V2=V1;
15 M=28;
16 Ro=8.314;
17
18 R=Ro/M;
19
20 P1=(m*R*T1)/V1;
```

```
21 printf('The initial pressure of gas: %3.3f bar',P1
   /100);
22 printf('\n');
23
24 P2=(P1*T2)/T1;
25 printf('The final pressure of gas: %3.3f bar',P2
   /100);
26 printf('\n');
```

Scilab code Exa 3.19.1 Example19

```
1  clc
2  clear
3
4  //Inputs
5  //The Values in the program are as follows:
6  //Temperature in Celcius converted to Kelvin(by
      adding 273)
7  //Pressure in bar converted to kPa (by multiplying
      100)
8  //Volume in m^3
9  //Value of R,Cp and Cv in kJ/kg K
10 T1=27+273;
11 V1=0.06;
12 P1=150;
13 Ro=8.314;
14 M=28;
15
16 R=Ro/M;
17 m=(P1*100*V1)/(R*T1);
18 printf('Mass of gas at design condition: %2.1f kg',m
   );
19 printf('\n');
20
21 P2=170;
```

```
22 T2=(T1*P2)/P1;
23 printf('Fusible plug should melt at: %3.0f K',T2);
24 printf('\n');
```

Scilab code Exa 3.20.1 Example20

```
1  clc
2  clear
3
4  //Inputs
5  //The Values in the program are as follows:
6  //Temperature in Celcius converted to Kelvin(by
       adding 273)
7  //Pressure in bar converted to kPa (by multiplying
       100)
8  //Volume in m^3
9  //Value of R,Cp and Cv in kJ/kg K
10 P1=7;
11 m=3.7;
12 V1=1.5;
13 P2=1.4;
14 V2=4.5;
15 U=648;
16 Cv=1.05;
17
18 RT1=(P1*100*V1)/(m);
19 RT2=(P2*100*V2)/(m);
20
21 RT=RT1-RT2;
22 T=(U)/(m*Cv);
23 R=(RT/T)
24 printf('The value of R: %1.3f kJ/kg K',R);
25 printf('\n');
26
27 Cp=Cv+R;
```

```
28 H=m*Cp*(-T);
29 printf('The change in enthalpy is: %4.2f kJ',H);
30 printf('\n');
31
32 T1=RT1/R;
33 T2=RT2/R;
34
35 printf('Initial Temperature: %3.2f K \n',T1);
36 printf('Final Temperature: %3.2f K \n',T2);
```

Scilab code Exa 3.21.1 Example21

```
1 clc
2 clear
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
    adding 273)
7 //Pressure in bar converted to kPa (by multiplying
    100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10 V=1.6;
11 P=1;
12 m=2;
13 T=17+273;
14 G=1.4;
15
16 R=(P*100*V)/(m*T);
17 Cv=(R)/(G-1);
18 printf('The Value of Cv: %1.2f kJ/kg K',Cv);
19 printf('\n');
20
21 Cp=Cv+R;
```

```
22 printf('The Value of Cp: %1.3f kJ/kg K',Cp);
23 printf('\n')
```

Scilab code Exa 3.22.1 Example22

```
1  clc
2  clear
3
4  //Inputs
5  //The Values in the program are as follows:
6  //Temperature in Celcius converted to Kelvin(by
       adding 273)
7  //Pressure in bar converted to kPa (by multiplying
       100)
8  //Volume in m^3
9  //Value of R,Cp and Cv in kJ/kg K
10 V1=0.091;
11 P1=2.73;
12 T1=187+273;
13 T2=27+273;
14 Cp=1.005;
15 Cv=0.718;
16
17 R=Cp-Cv;
18
19 m=(P1*100*V1)/(R*T1);
20 Q=m*Cp*(T2-T1);
21 printf('The Value of heat transferred: %1.2f kJ',Q);
22 printf('\n')
23
24 V2=(T2*V1)/T1;
25 W=P1*100*(V2-V1);
26 printf('The Value of Work done: %1.2f kJ',W);
27 printf('\n')
```

Scilab code Exa 3.23.1 Example23

```
clc
clear

//Inputs
//The Values in the program are as follows:
//Temperature in Celcius converted to Kelvin(by adding 273)
//Pressure in bar converted to kPa (by multiplying 100)
//Volume in m^3
//Value of R,Cp and Cv in kJ/kg K
m=28;
V1=3;
T1=100+273;
T2=37+273;
G=1.4;
Ro=8.314;

v=V1/m;
R=Ro/m;

P1=(m*R*T1)/V1;

printf('The Specific Volume: %1.3f m^3/kg',v);
printf('\n')

printf('The Initial Pressure: %1.2f kPa',P1);
printf('\n')

P2=(P1*T2)/T1;
printf('The Final Pressure: %1.2f kPa',P2);
printf('\n')
```

```
31
32 Cv=(R)/(G-1);
33 Cp=Cv*G;
34 U=m*Cv*(T2-T1);
35 H=m*Cp*(T2-T1);
36
37 printf('Change in Internal Energy: %1.2f kJ',U);
38 printf('\n');
39
40
41 printf('Change in Heat energy: %1.2f kJ',H);
42 printf('\n')
```

Scilab code Exa 3.24.1 Example24

```
1 clc
2 clear
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
     adding 273)
7 //Pressure in bar converted to kPa (by multiplying
     100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10 V1=3;
11 V1=V1*100;       //In kPa
12 P1=2;
13 T1=73+273;
14 P2=7;
15 R=0.287;
16 Cv=0.718;
17 Cp=1.005;
18
```

```
m=(P1*V1)/(R*T1);
T2=(P2*T1)/P1;

U=m*Cv*(T2-T1);
H=m*Cp*(T2-T1);

printf('Change in Internal Energy: %1.2f kJ',U);
printf('\n');

printf('Change in heat Energy: %1.2f kJ',H);
printf('\n')
```

Scilab code Exa 3.25.1 Example25

```
clc
clear

//Inputs
//The Values in the program are as follows:
//Temperature in Celcius converted to Kelvin(by
   adding 273)
//Pressure in bar converted to kPa (by multiplying
   100)
//Volume in m^3
//Value of R,Cp and Cv in kJ/kg K
m=1;
T1=27+273;
T2=197+273;
V1=2.1;
R=0.287;
Cp=1.005;

W=m*R*(T2-T1);
printf('Work Done: %1.2f kJ',W);
printf('\n');
```

```
20
21 Q=m*Cp*(T2-T1);
22 U=Q-W;
23
24 printf('Change in Heat Energy: %1.2f kJ',Q);
25 printf('\n');
26 printf('Change in Internal Energy: %1.2f kJ',U);
27 printf('\n');
28
29 P=(m*R*T1)/(V1);
30 V2=(V1*T2)/(T1);
31 printf('Pressure: %1.2f kPa',P);
32 printf('\n');
33 printf('Final Volume: %1.1f m^3',V2);
34 printf('\n');
```

Scilab code Exa 3.26.1 Example26

```
1 clc
2 clear
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
    adding 273)
7 //Pressure in bar converted to kPa (by multiplying
    100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10 V1=0.5;
11 P1=0.3;
12 V2=0.1;
13 P2=(P1*V1)/(V2);
14 printf('Final Pressure: %1.2f bar',P2);
15 printf('\n');
```

```
16
17 W=(P1*100*V1)*(log(V2/V1));
18 printf('Work Done: %1.2f kJ',W);
19 printf('\n');
20
21 printf('Change in Internal Energy: 0 kJ as it is
      Isothermal Process');
22 printf('\n');
23
24 printf('Change in Heat Energy: %1.2f kJ',W);
25 printf('\n');
```

Scilab code Exa 3.27.1 Example27

```
1 clc
2 clear
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
      adding 273)
7 //Pressure in bar converted to kPa (by multiplying
      100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10 m=0.19;
11 P1=1;
12 V1=0.16;
13 T1=17+273;
14 P2=4.1;
15 V2=0.046;
16 Ro=8.314;
17
18 R=(P1*100*V1)/(m*T1);
19 printf('Gas Constant: %1.2f kJ/kg K',R);
```

```
20 printf('\n');
21
22 M=Ro/R;
23 printf('Molecular Mass: %1.2f kg/kg mole',M);
24 printf('\n');
25
26 G=(log(P1/P2))/(log(V2/V1));
27 printf('Ratio of Specific Heats: %1.2f ',G);
28 printf('\n');
29
30 Cv=(R)/(G-1);
31 printf('Value of Cv: %1.2f kJ/kg K',Cv);
32 printf('\n');
33
34 Cp=G*Cv;
35 printf('Value of Cp: %1.2f kJ/kg K',Cp);
36 printf('\n');
37
38 T2=(P2*100*V2)/(m*R);
39 U=m*Cv*(T2-T1);
40 printf('Change in Internal Energy: %1.2f kJ',U);
41 printf('\n');
42
43 H=m*Cp*(T2-T1);
44 printf('Heat Transfer: %1.2f kJ',H);
45 printf('\n');
46
47 W=((P1*100*V1)-(P2*100*V2))/(G-1);
48 printf('Work Done: %1.2f kJ',W);
49 printf('\n');
```

Scilab code Exa 3.28.1 Example28

```
1 clc
2 clear
```

```
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
     adding 273)
7 //Pressure in bar converted to kPa (by multiplying
     100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10 V1=0.19;
11 P1=5;
12 T1=190+273;
13 P2=1;
14 H=100;
15 G=1.4;
16 R=0.287;
17 Cp=1.005;
18
19 V2=V1*((P1/P2)^(1/G));
20 W=((P1*100*V1)-(P2*100*V2))/(G-1);
21 m=(P1*100*V1)/(R*T1);
22 T2=T1*((P2/P1)^((G-1)/G))
23 x=H/(m*Cp);
24 T3=x+T2;
25
26 V3=(V2*T3)/T2;
27 Wo=P2*100*(V3-V2);
28 Wf=W+Wo;
29 printf('Total Work Done: %1.2f kJ',Wf);
30 printf('\n');
```

Scilab code Exa 3.29.1 Example29

```
1 clc
2 clear
```

```
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
     adding 273)
7 //Pressure in bar converted to kPa (by multiplying
     100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10 V1=0.1;
11 V3=V1;
12 P1=10;
13 T1=200+273;
14 P2=3;
15 R=0.287;
16 G=1.4;
17 Cv=0.718;
18
19 m=(P1*100*V1)/(R*T1);
20 T2=T1*((P2/P1)^((G-1)/G));
21 V2=V1*((P1/P2)^((1)/G));
22 T3=T2;
23 P3=(P2*V2)/V3;
24 printf('Pressure after Isothermal Compression: %1.2f
      bar',P3);
25 printf('\n');
26 printf('Temperature after isothermal compression: %1
     .2f K',T2);
27 printf('\n');
28
29 W1=((P1*100*V1)-(P2*100*V2))/(G-1);
30 printf('Work Developed during adiabatic expansion:
     %2.0f kJ',W1);
31 printf('\n');
32
33 W2=(P2*100*V2)*log(V3/V2);
34 printf('Work of Compression: %1.2f kJ',W2);
35 printf('\n');
```

```
36
37 Q=m*Cv*(T1-T3);
38 printf('Heat supplied in 3rd Process: %1.2f kJ',Q);
39 printf('\n');
40
41 U=m*Cv*(T2-T1);
42 printf('Change in Internal Energy: %1.2f kJ',U);
43 printf('\n');
```

Scilab code Exa 3.30.1 Example30

```
1  clc
2  clear
3
4  //Inputs
5  V1=0.028;
6  P1=1;
7  T1=27+273;
8  n=1.3;
9  V2=0.0046;
10 T3=T1;
11
12 T2=T1*((V1/V2)^(n-1));
13 printf('Temperature after compression: %1.2f K',T2);
14 printf('\n');
15
16 P2=P1*((V1/V2)^n);
17 W=((P1*100*V1)-(P2*100*V2))/(n-1);
18 printf('Work Done: %1.2f kJ',W);
19 printf('\n');
20
21 P3=(T3*P2)/T2;
22 printf('Final Pressure: %1.2f bar',P3);
23 printf('\n');
```

Scilab code Exa 3.31.1 Example31

```
clc
clear

//Inputs
//The Values in the program are as follows:
//Temperature in Celcius converted to Kelvin(by adding 273)
//Pressure in bar converted to kPa (by multiplying 100)
//Volume in m^3
//Value of R,Cp and Cv in kJ/kg K
V1=0.15;
P1=900;
T1=300+273;
T3=T1;
V2=3*V1;
R=0.287;
Cp=1.005;
G=1.4;
n=1.5;
Cv=0.718;

//Calculations
m=(P1*V1)/(R*T1);
T2=(V2*T1)/V1;
Q1=m*Cp*(T2-T1);
printf('Heat Received: %3.2f kJ',Q1);
printf('\n');

Q2=(m*Cv)*((n-G)/(n-1))*(T3-T2);
Q3=m*R*T3*(log(1/27));
Qr=0-(Q2+Q3);
```

```
31 printf('Heat Rejected: %3.2f kJ',Qr);
32 printf('\n');
33
34 Eff=(1-(Qr/Q1))*100;
35 printf('Efficiency: %3.2f percent',Eff);
36 printf('\n');
```

Scilab code Exa 3.32.1 Example32

```
1  clc
2  clear
3
4  //Inputs
5  //The Values in the program are as follows:
6  //Temperature in Celcius converted to Kelvin(by
       adding 273)
7  //Pressure in bar converted to kPa (by multiplying
       100)
8  //Volume in m^3
9  //Value of R,Cp and Cv in kJ/kg K
10 M=27;
11 P1=1;
12 T1=60+273;
13 n=1.3;
14 Cvm=21;
15 Ro=8.314;
16 R=Ro/M;
17
18 //Calculations
19 V1=(R*T1)/(P1*100);
20 V2=V1/12;
21 x=V1/V2;
22 P2=P1*(x^n);
23 W=((P1*100*V1)-(P2*100*V2))/(n-1);
24 printf('Work Done: %3.2f kJ/kg',W);
```

```
25 printf('\n');
26
27 Cv=Cvm/M;
28 Cp=Cv+R;
29 G=Cp/Cv;
30
31 Q=((G-n)/(G-1))*W;
32 printf('Heat Transfer during the process: %3.2f kJ/
     kg',Q);
33 printf('\n');
```

Scilab code Exa 3.33.1 Example33

```
1 clc
2 clear
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
     adding 273)
7 //Pressure in bar converted to kPa (by multiplying
     100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10 D=0.550;
11 L=0.740;
12 r=12;
13 P1=100;
14 T1=27+273;
15 n=1.32;
16 R=0.287;
17 G=1.4;
18 V=((22/7)/4)*D*D*L;
19 V2=V/11;
20 V1=V2+V;
```

```
21 P2=P1*((r)^n);
22 T2=T1*((r)^(n-1));
23 printf('The Pressure at end of Compression: %3.3f
     kPa',P2);
24 printf('\n');
25 printf('The Temperature at end of Compression: %3.3f
     K',T2);
26 printf('\n');
27 m=(P1*V1)/(R*T1);
28 printf('The Mass in the cylinder: %3.3f kg',m);
29 printf('\n');
30 W=((P1*V1)-(P2*V2))/(n-1);
31 printf('The Work Done: %3.3f kJ',W);
32 printf('\n');
33 Q=((G-n)/(G-1))*W;
34 printf('The Heat Transfer: %3.3f kJ',Q);
35 printf('\n');
```

Scilab code Exa 3.34.1 Example34

```
1 clc
2 clear
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
     adding 273)
7 //Pressure in bar converted to kPa (by multiplying
     100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10 m=1;
11 P1=10;
12 T1=337+273;
13 P2=1;
```

```
14 V=6;
15 R=0.287;
16 G=1.4;
17 x=log(P2/P1);
18 y=log(1/V);
19 n=x/y;
20 printf('The Value of n: %3.3f ',n);
21 printf('\n');
22 V1=(m*R*T1)/(P1*100);
23 V2=V1*6;
24 W=((P1*100*V1)-(P2*100*V2))/(n-1);
25 printf('The Work Done: %3.1f kJ',W);
26 printf('\n');
27 Q=((G-n)/(G-1))*W;
28 printf('The Heat Transfer: %3.2f kJ',Q);
29 printf('\n');
```

Scilab code Exa 3.37.1 Example37

```
1 clc
2 clear
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
    adding 273)
7 //Pressure in bar converted to kPa (by multiplying
    100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10 T1=430;
11 T2=289.25;
12 P2=100;
13 P1=400;
14 G=1.4;
```

```
15 V1=0.2;
16 R=287;
17 Q=60;
18 Cp=1.005;
19 T2=T1*((P2/P1)^((G-1)/G));
20 V2=V1*((P1/P2)^(1/G));
21 m=(P1*1000*V1)/(R*T1);
22 W1=(m*(R/1000)*(T1-T2))/(G-1);
23 T3=(Q/(m*Cp))+T2;
24 V3=(V2*T3)/T2;
25 W2=P2*(V3-V2);
26 W=W1+W2;
27 printf('The Net Work Done: %3.3f kJ',W);
28 printf('\n');
29 n=((m*(R/1000)*(T1-T3))/W)+1;
30 printf('The value of n: %3.2f ',n);
31 printf('\n');
```

Scilab code Exa 3.38.1 Example38

```
1 clc
2 clear
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
    adding 273)
7 //Pressure in bar converted to kPa (by multiplying
    100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg Km=1;
10 P1=6;
11 V1=0.01;
12 V2=0.05;
13 P2=2;
```

```
14 W1=(((P1+P2)/2)*100)*(V2-V1);
15 printf('The Work done for first cycle: %3.1f kJ',W1)
     ;
16 printf('\n');
17 P3=P2;
18 V3=(P1*V1)/P3;
19 W2=P2*100*(V3-V2);
20 printf('The Work done for second cycle: %3.1f kJ',W2
     );
21 printf('\n');
22 W3=(P3*100*V3)*(log(V1/V3));
23 printf('The Work done for third cycle: %3.2f kJ',W3)
     ;
24 printf('\n');
25 W=W1+W2+W3;
26 printf('The net Work done: %3.2f kJ',W);
27 printf('\n');
28 Q=W;                    //As process is cyclic
29 printf('The Heat Transfer: %3.2f kJ',Q);
30 printf('\n');
```

Scilab code Exa 3.39.1 Example39

```
1 clc
2 clear
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
     adding 273)
7 //Pressure in bar converted to kPa (by multiplying
     100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10 V1=0.6;
```

```
11 P1=1;
12 T1=90+273;
13 V2=0.18;
14 P2=5;
15 R=0.287;
16 G=1.4;
17
18 m=(P1*100*V1)/(R*T1);
19 printf('The mass of Gas: %3.4f kg',m);
20 printf('\n');
21 n=(log(P2/P1))/(log(V1/V2));
22 printf('The value of n: %3.3f ',n);
23 printf('\n');
24 Cv=R/(G-1);
25 T2=((P2*V2)/(P1*V1))*T1;
26 U=m*Cv*(T2-T1);
27 printf('The change in Internal Energy: %3.3f kJ',U);
28 printf('\n');
```

Scilab code Exa 3.40.1 Example40

```
1 clc
2 clear
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
     adding 273)
7 //Pressure in bar converted to kPa (by multiplying
     100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10 R=0.29;
11 Cp=1.005;
12 P1=2.75;
```

```
13 P2=P1;
14 V1=0.09;
15 T1=185+273;
16 T2=15+273;
17
18 //Calculations
19 V2=(V1*T2)/T1;
20 m=(P1*100*V1)/(R*T1);
21 Q=m*Cp*(T2-T1);
22 printf('The Heat Transfer: %3.3f kJ',Q);
23 printf('\n');
24 W=P1*100*(V2-V1);
25 printf('The Work done: %3.3f kJ',W);
26 printf('\n');
```

Scilab code Exa 3.41.1 Example41

```
1 clc
2 clear
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
    adding 273)
7 //Pressure in bar converted to kPa (by multiplying
    100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg K
10 T1=25+273;
11 T2=145+273;
12 m=2;
13 R=267;
14 G=1.4;
15 Cv=R/(G-1);
16 printf('The value of Cv: %3.1f J/kg K',Cv);
```

```
17 printf('\n');
18 Cp=G*Cv;
19 printf('The value of Cp: %3.1f J/kg K',Cp);
20 printf('\n');
21 U=m*Cv*(T2-T1)*(1/1000);
22 printf('The change in Internal Energy: %3.1f kJ',U);
23 printf('\n');
24 H=m*Cp*(T2-T1)*(1/1000);
25 printf('The Heat Transfer: %3.1f kJ',H);
26 printf('\n');
```

Scilab code Exa 3.42.1 Example42

```
1  clc
2  clear
3
4  //Inputs
5  //The Values in the program are as follows:
6  //Temperature in Celcius converted to Kelvin(by
       adding 273)
7  //Pressure in bar converted to kPa (by multiplying
       100)
8  //Volume in m^3
9  //Value of R,Cp and Cv in kJ/kg K
10 D=1;
11 h=4;
12 P1=100;
13 T1=27+273;
14 P2=125;
15 Cp=14.307;
16 Cv=10.183;
17 V1=(22/7)*(1/4)*(D*D*h);
18 R=Cp-Cv;
19 m=(P1*V1)/(R*T1);
20 T2=(P2*T1)/P1;
```

```
21 Q=m*Cv*(T2-T1);
22 printf('The Heat Transfer: %3.0f kJ',Q);
23 printf('\n');
```

Scilab code Exa 3.43.1 Example43

```
1  clc
2  clear
3
4  //Inputs
5  //The Values in the program are as follows:
6  //Temperature in Celcius converted to Kelvin(by
       adding 273)
7  //Pressure in bar converted to kPa (by multiplying
       100)
8  //Volume in m^3
9  //Value of R,Cp and Cv in kJ/kg K
10 V1=0.15;
11 V2=3*V1;
12 P1=900;
13 P2=P1;
14 T1=300+273;
15 T3=T1;
16 n=1.5;
17 G=1.4;
18 R=0.287;
19 Cp=1.005;
20 m=(P1*V1)/(R*T1);
21 T2=(T1*V2)/V1;
22 Q1=m*Cp*(T2-T1);
23 W1=m*R*(T2-T3)/(n-1);
24 Q2=(G-n)*W1/(G-1);
25 P3=P2*((T3/T2)^(G/(G-1)));
26 Q3=m*R*T1*log(P3/P1);
27 H_rec=Q1;
```

```
28 printf('The Heat received: %3.1f kJ',H_rec);
29 printf('\n');
30 H_rej=0-(Q2+Q3);
31 printf('The Heat Rejected: %3.1f kJ',H_rej);
32 printf('\n');
33 eff=100*(1-(H_rej/H_rec));
34 printf('Efficiency: %3.2f percent',eff);
35 printf('\n');
```

Scilab code Exa 3.44.1 Example44

```
1 clc
2 clear
3
4 //Inputs
5 //The Values in the program are as follows:
6 //Temperature in Celcius converted to Kelvin(by
     adding 273)
7 //Pressure in bar converted to kPa (by multiplying
     100)
8 //Volume in m^3
9 //Value of R,Cp and Cv in kJ/kg Km=1;
10 V1=0.15;
11 P1=1;
12 V2=0.05;
13 G=1.4;
14
15 //Calculations
16 P2=(V1*P1)/V2;
17 W_it=P1*100*V1*log(P1/P2);
18 printf('Work done in Isothermal process: %2.2f kJ',
     W_it);
19 printf('\n');
20 P2=P1*((V1/V2)^G);
21 W_ad=((P1*100*V1)-(P2*100*V2))/(G-1);
```

```
22 printf('Work done in Adiabatic process: %2.2f kJ',
      W_ad);
23 printf('\n');
```

Scilab code Exa 3.45.1 Example45

```
1  clc
2  clear
3
4  //Inputs
5  //The Values in the program are as follows:
6  //Temperature in Celcius converted to Kelvin(by
      adding 273)
7  //Pressure in bar converted to kPa (by multiplying
      100)
8  //Volume in m^3
9  //Value of R,Cp and Cv in kJ/kg K
10 m=1;
11 Cp=1.005;
12 P1=100;
13 T1=17+273;
14 T2=T1;
15 P2=2500;
16 printf('Final Temperature: %2.2f K',T2);
17 printf('\n');
18
19 V1=(260*T1)/(P1*1000);
20 V2=(P1*V1)/P2;
21 printf('Final Volume: %2.5f m^3',V2);
22 printf('\n');
23 n=P2/P1;
24 printf('Compression ratio: %2.0f ',n);
25 printf('\n');
26 H=m*Cp*(T2-T1);
27 printf('Change in Enthalpy: %2.2f kJ',H);
```

```
28 printf('\n');
29 W=P1*V1*log(P1/P2);
30 printf('Work done: %2.2f kJ/kg',W);
31 printf('\n');
```

Scilab code Exa 3.46.1 Example46

```
1  clc
2  clear
3
4  //Inputs
5  //The Values in the program are as follows:
6  //Temperature in Celcius converted to Kelvin(by
       adding 273)
7  //Pressure in bar converted to kPa (by multiplying
       100)
8  //Volume in m^3
9  //Value of R,Cp and Cv in kJ/kg K
10 P1=150;
11 T1=17+273;
12 P2=750;
13 n=1.3;
14 m=1;
15 R=0.287;
16 Cp=1.001;
17
18 //Calculations
19 T2=T1*((P2/P1)^((n-1)/n));
20 printf('The final temperature: %2.1f K',T2);
21 printf('\n');
22 W=m*R*(T1-T2)/(n-1);
23 printf('Work done: %2.2f kJ/kg',W);
24 printf('\n');
25 Cv=Cp-R;
26 U=m*Cv*(T2-T1);
```

```
27 printf('Change in internal energy: %2.2f kJ/kg',U);
28 printf('\n');
29 G=Cp/Cv;
30 Q=((G-n)/(G-1))*W;
31 printf('Amount of heat transfer: %2.2f kJ/kg',Q);
32 printf('\n');
33 H=m*Cp*(T2-T1);
34 printf('Change in enthalpy: %2.2f kJ/kg',H);
35 printf('\n');
```

Chapter 4

Properties of Steam

Scilab code Exa 4.1.1 Example 1

```
1  clc
2  clear
3
4  //Case 1
5  Vg=0.132;
6  SV=0.12;          //Specific Volume
7  //As SV is less than Vg, steam is wet
8
9  x=SV/Vg;
10
11 printf('\n For Case 1 \n');
12 printf('Part of wet steam: %2.2f',x);
13 printf('\n');
14
15 //Case 2
16 T=200;
17 Tsat=179.9;       //Satuaration Temperature
18 //Steam is superheated as T > Tsat
19 D_sh=T-Tsat;
20
21 printf('\n For Case 2 \n');
```

```
22 printf('Degree of Superheat: %2.1f C',D_sh);
23 printf('\n');
24
25 //Case 3
26 P=20;          //Pressure in bars
27 Hf=908.8;          //kJ/kg
28 Hfg=1890.7;        //kJ/kg
29 Hg=2799.5;        //kJ/kg
30 H=2650;
31
32 //Steam is wet as Specific enthalpy is less than Hg
33
34 x=(H-Hf)/Hfg;
35
36 printf('\n For Case 3 \n');
37 printf('Part of wet steam: %2.2f',x);
38 printf('\n');
39
40 //Case 4
41 T=150;         //in Celcius
42 SV=0.3928;     //Specific Volume in m^3/kg
43 Vg=0.3928;     //in m^3/kg
44
45 printf('\n For Case 4 \n');
46 printf('As SV=Vg, steam is dry saturated');
47 printf('\n');
48
49 //Case 5
50 P=10;          //in bars
51 S=5.697;
52 Sf=2.319;
53 Sfg=4.448;
54 Sg=6.623;
55 //As Sample specific entropy is less than Sg and
      more than Sf, steam is wet
56
57 x=(S-Sf)/Sfg;
58 printf('\n For Case 5 \n');
```

```
59 printf('Part of wet steam: %2.1f',x);
60 printf('\n');
```

Scilab code Exa 4.2.1 Example 2

```
1  clc
2  clear
3
4  //At 10 bar pressure
5  P=10;        //in bars
6  x=0.8;
7  Vg=0.194;    //in kJ/kg
8  W=P*100*x*Vg;
9  printf('External Work Done: %3.2f kJ/kg',W);
10 printf('\n');
11
12 Hf=762.8;         //in kJ/kg
13 Hfg=2015.3;       //in kJ/kg
14 H=Hf+(x*Hfg);
15 U=H-W;
16 printf('Internal energy: %3.2f kJ/kg',U);
17 printf('\n');
18
19 Vf=0.001127;          //in m^3/kg
20 Uf=Hf-(P*100*Vf);
21 Ux=U-Uf;
22 printf('Internal Heat of Evaporation: %3.2f kJ/kg',
      Ux);
23 printf('\n');
24
25 Sf=2.139;         //in kJ/kg K
26 Sfg=4.448;        //in kJ/kg K
27 S=Sf+(x*Sfg);
28 printf('Entropy of steam: %3.3f kJ/kg',S);
29 printf('\n');
```

Scilab code Exa 4.3.1 Example 3

```
clc
clear

//Condition at 10 bar pressure
//Steam is wet

x=0.95;
P=10;          //in bars
Hf=762.8;          //in kJ/kg
Hfg=2015.3;        //in kJ/kg
H=Hf+(x*Hfg);
printf('Enthalpy : %3.2f kJ/kg',H);
printf('\n');

//Now we calculate Work Done
Vg=0.194;          //in m^3/kg
W=P*100*x*Vg;
U=H-W;
printf('Internal energy: %3.0f kJ/kg',U);
printf('\n');
```

Scilab code Exa 4.4.1 Example 4

```
clc
clear

//Condition at pressure 15 bars
P=15;          //in bars
Hf=844.9;      // in kJ/kg
```

```
7  Hfg=1947.3; //in kJ/kg
8  Vg=0.132;   //in m^3/kg
9  x=0.9;      //Dryness fraction
10
11 W=P*100*x*Vg;
12 printf('External Work Done: %3.2f kJ/kg',W);
13 printf('\n');
14 H=Hf+(x*Hfg);
15 U=H-W;
16 printf('Internal Energy: %3.1f kJ/kg',U);
17 printf('\n');
```

Scilab code Exa 4.5.1 Example 5

```
1  clc
2  clear
3
4  x=0.9;      //Dryness Fraction
5  m=1.5;      //mass in kg
6  Cps=2.1;
7  //Condition at 10 bars
8  P=10;
9  Tsat=179.9;     //in Celcius
10 T=250;          //in Celcius
11 Hg=2778.1;      //in kJ/kg
12 Vg=0.194;       //in m^3/kg
13 Cps=2.1;
14 H1=Hg+(Cps*(T-Tsat));
15 Vsup=((T+273)/(Tsat+273))*Vg;
16 U1=H1-(P*100*Vsup);
17 Sf=2.139;       //in kJ/kg K
18 Sfg=4.448;      //in kJ/kg K
19 Sg=6.623;       //in kJ/kg K
20 S1=Sg+(Cps*log((T+273)/(Tsat+273)));
21
```

```
22 //Conditions at 2.8 bars
23 P2=2.8;
24 Hf=551.4;          //in kJ/kg
25 Hfg=2170.7;       //in kJ/kg
26 Vg=0.646;         //in m^3/kg
27 H2=Hf+(x*Hfg);
28 U2=H2-(P2*100*x*Vg);
29 Sf=1.647;         //in kJ/kg K
30 Sfg=5.368;        //in kJ/kg K
31 S2=Sf+(x*Sfg);
32 U=m*(U2-U1);
33 printf('The change in internal energy: %3.1f kJ/kg',
      U);
34 printf('\n');
35 S=S2-S1;
36 printf('The change in Entropy: %3.4f kJ/kg K',S);
37 printf('\n');
```

Scilab code Exa 4.6.1 Example 6

```
1  clc
2  clear
3
4  //Conditions at 8 bar
5  P=8;                  //Pressure in bar
6  x=0.9;                //dryness fraction
7  Hf=721.1;             //in kJ/kg
8  Hfg=2048.0;           //in kJ/kg
9  Vg=0.240;             //in m^3/kg
10 H1=Hf+(x*Hfg);
11 V1=x*Vg;
12
13 //Enthalpy of superheated steam at 8 bar and 200
      Celcius
14 Hg=2769.1;
```

```
15 Cps=2.1;
16 Tsup=200+273;            //in Celcius
17 Tsat=170.4+273;          //in Celcius
18 H2=Hg+(Cps*(Tsup-Tsat));
19 V2=(Vg*Tsup)/Tsat;
20 H=H2-H1;
21 printf('Heat supplied: %3.1f kJ/kg',H);
22 printf('\n');
23 W=P*100*(V2-V1);
24 printf('Work Done: %3.3f kJ/kg',W);
25 printf('\n');
26 //At 8 bar
27 Sf=2.046;              //in kJ/kg K
28 Sfg=4.617;             //in kJ/kg K
29 Sg=6.663;              //in kJ/kg K
30 S1=Sf+(x*Sfg);
31 S2=Sg+(Cps*(log(Tsup/Tsat)));
32 S=S2-S1;
33 printf('The Enthalpy change during process: %3.1f kJ
     /kg K',S);
34 printf('\n');
```

Scilab code Exa 4.7.1 Example 7

```
1 clc
2 clear
3
4 //Conditions at 10 bar
5 P1=10;                  //in bars
6 Hg=2778.1;              //in kJ/kg
7 Tsat=179.9+273;         //Temperature in K
8 Vg=0.194;               //in m^3/kg
9
10 //Conditions at 10 bar and 300 Celcius
11 Cps=2.1;
```

```
12 Tsup=300+273;
13 H1=Hg+(Cps*(Tsup-Tsat));
14 V1=Vg*(Tsup/Tsat);
15 U1=H1-(P1*100*V1);
16 printf('The Internal energy: %3.1f kJ/kg',U1);
17 printf('\n');
18
19 //At 1.4 bar and other conditions
20 P2=1.4;                  //in bars
21 x=0.8;                   //Dryness Fraction
22 Hf=458.4;                //in kJ/kg
23 Hfg=2232.0;              //in kJ/kg
24 Vg=1.237;                //in m^3/kg
25 H2=Hf+(x*Hfg);
26 V2=x*Vg;
27 U2=H2-(P2*100*V2);
28 U=U2-U1;
29 printf('The change in internal energy: %3.1f kJ/kg',
      U);
30 printf('\n');
```

Scilab code Exa 4.8.1 Example 8

```
1 clc
2 clear
3
4 //Conditions at 8 bar
5 P=8;                  //in bars
6 x=0.8;                //Dryness Fraction
7 Hf=721.1;             //in kJ/kg
8 Hfg=2048.0;           //in kJ/kg
9 H1=Hf+(x*Hfg);
10 H2=H1+410;                //After adding 410 kJ of heat
11 Hg=2769.1;           //in kJ/kg
12 printf('The Enthalpy of steam: %3.1f kJ/kg',H2);
```

```
13 printf('\n');
14 printf('The steam is superheated')
15 printf('\n');
16 V2=0.240;          //in m^3/kg
17 Vg=V2;
18 Den=1/Vg;
19 printf('The Density of steam: %3.3f kg/m^3',Den);
20 printf('\n');
```

Scilab code Exa 4.9.1 Example 9

```
1  clc
2  clear
3
4  //For throttling H1=H2
5
6  //At 11 bar
7  Hf=781.3;              //in kJ/kg
8  Hfg=2000.4;            //in kJ/kg
9
10 //At 1 bar
11 Hg=2675.5;             //in kJ/kg
12 x=(Hg-Hf)/Hfg;
13 printf('The Dryness Fraction: %3.3f kJ/kg',x);
14 printf('\n');
```

Scilab code Exa 4.10.1 Example 10

```
1  clc
2  clear
3
4  //Conditions at 4 bar
5  P1=4;                  //in bars
```

```
Hf=604.7;              //in kJ/kg
Hfg=2133.8;            //in kJ/kg
Vg=0.463;              //in m^3/kg
x1=0.9;
H1=Hf+(x1*Hfg);
V1=x1*Vg;

//Now at 12 bar pressure
P2=12;                 //in bars
V2=(P1*V1)/P2;
Vg=0.163;              //in m^3/kg
printf('At 12 bar, V2: %3.3f kJ/kg',V2);
printf('\n');
printf('As Vg>V2, steam is wet');
printf('\n');
x2=V2/Vg;
printf('The dryness fraction at 12 bars: %3.2f ',x2)
   ;
printf('\n');

Hf=798.6;              //in kJ/kg
Hfg=1986.2;            //in kJ/kg
H2=Hf+(x2*Hfg);
printf('The Final enthalpy of steam: %3.1f kJ/kg',H2
   );
printf('\n');
```

Scilab code Exa 4.11.1 Example 11

```
clc
clear

//At 20 degree Celcius
Cpw=4.187;                  //in kJ/kg
Tw=20;
```

```
7  H1=Cpw*Tw;
8
9  //At 8 bar condition
10 m=4;                  //mass in kg
11 Cps=2.1;              //in kJ/kg
12 Tsat=170.4+273;       //in K
13 Hg=2769.1;            //in kJ/kg
14 Tsup=200+273;         //in K
15 H2=Hg+(Cps*(Tsup-Tsat));
16 Q=m*(H2-H1);
17 printf('Heat to be added: %3.1f kJ',Q);
18 printf('\n');
```

Scilab code Exa 4.12.1 Example 12

```
1  clc
2  clear
3
4  //Combined Seperating and Throttling Calorimeter
5  m1=2;        //mass of water seperated in kg
6  m=20.5;      //Steam discharged from calorimeter in
      kg
7  mt=m1+m;     //Steam inlet in kg
8
9  x1=m/(mt);       //Dryness fraction
10
11 //At 12 bar pressure
12 Hf=798.6;        //in kJ/kg
13 Hfg=1986.2;      //in kJ/kg
14
15 P_bar=760;           //Pressure in mm
16 P_fin=5;             //Pressure in mm
17 P=(P_bar+P_fin)*1.01325/P_bar;      //Absolute
      Pressure
18
```

```
19 //Now at 1.02 bar
20 Cp=2.2;          //in kJ/kg K
21 Hg=2676.34;          //in kJ/kg
22 Tsat=99.66+273;      //in K
23 Tsup=110+273;        //in K
24 H2=Hg+(Cp*(Tsup-Tsat));
25 x2=(H2-Hf)/Hfg;
26 x=x1*x2;
27 printf('The Dryness Fraction: %3.3f',x);
28 printf('\n');
```

Scilab code Exa 4.13.1 Example 13

```
1  clc
2  clear
3
4  //At 7 bar and 300 Celcius
5  P=7;              //in bars
6  Cps=2.1;
7  Tsup=300+273;     //in K
8  Tsat=165+273;     //in K
9  Hg=2763.5;        //in kJ/kg
10 H1=Hg+(Cps*(Tsup-Tsat));
11
12 x2=0.9;            //Dryness Fraction
13 Hf=697.2;         //in kJ/kg
14 Hfg=2066.3;       //in kJ/kg
15 H2=Hf+(x2*Hfg);
16 m=(H1-Hg)/(Hg-H2);
17 printf('The mass flow rate of wet steam: %3.3f kg/kg
       ',m);
18 printf('\n');
```

Scilab code Exa 4.14.1 Example 14

```
clc
clear

//Conditions at 10 bar
P=10;                       //in bar
Tsat=179.9+273;             //in K
Hf=762.8;                   //in kJ/kg
Hfg=2015.3;                 //in kJ/kg
Hg=2778.1;                  //in kJ/kg
Vg=0.194;                   //in m^3/kg
Sf=2.139;                   //in kJ/kg K
Sg=6.623;                   //in kJ/kg K
Sfg=4.448;                  //in kJ/kg K
x=0.91;                     //Dryness Fraction
m=3;                        //in kg

//Now for wet steam
H=Hf+(x*Hfg);
H_final=m*H;
printf('The total Enthalpy: %3.1f kJ',H_final);
printf('\n');
V=x*Vg;
U=H-(P*100*V);
U_final=m*U;
printf('The Internal Energy: %3.1f kJ',U_final);
printf('\n');
S=Sf+(x*Sfg);
S_final=m*S;
printf('The Entropy: %3.3f kJ/K',S_final);
printf('\n \n');

//Now Case 2
printf('Now for Case 2 \n');
Tsat=179.9+273;             //in K
Tsup=200+273;               //in K
Cp=2.1;                     //in kJ/kg K
```

```
37 H=Hg+(Cp*(Tsup-Tsat));
38 H_final=m*H;
39 printf('The Enthalpy: %3.1f kJ',H_final);
40 printf('\n');
41 Vsup=(Tsup*Vg)/Tsat;
42 U=H-(P*100*Vsup);
43 U_final=m*U;
44 printf('The change in internal energy: %3.1f kJ',
     U_final);
45 printf('\n');
46 S=Sg+(Cp*log(Tsup/Tsat));
47 S_final=m*S;
48 printf('The Entropy: %3.1f kJ/K',S_final);
49 printf('\n');
50
51 //Now Case 3
52 printf('\n Now for case 3 \n');
53 H=Hg;
54 H_final=m*H;                    //in  kJ
55 printf('The total enthalpy: %3.1f kJ',H_final);
56 printf('\n');
57 V=Vg;
58 U=H-(P*100*V);
59 U_final=m*U;
60 printf('The change in internal energy: %3.1f kJ',
     U_final);
61 printf('\n');
62 S=Sg;
63 S_final=m*S;
64 printf('The total entropy: %3.3f kJ/kg',S_final);
65 printf('\n');
```

Scilab code Exa 4.15.1 Example 15

```
1 clc
```

```
clear

//At 15 bar condition
Tsat=198.3+273;          //in K
m=7;                     //in kg
Hg=2792.2;               //in kJ/kg
Tsup=300+273;            //in K
Cps=2.1;                 //in kJ/kg K
H1=Hg+(Cps*(Tsup-Tsat));
Cpw=4.187;               //in kJ/kg K
H2=Cpw*50;
Q=m*(H1-H2);
printf('The total amount of heat required: %3.1f kJ'
   ,Q);
printf('\n');
Sg=6.445;                //in kJ/kg K
S2=Sg+(Cps*log(Tsup/Tsat));
Sf=0.704;                //in kJ/kg K
S1=Sf;
S=m*(S2-S1);
printf('The change in Entropy: %3.2f kJ/K',S);
printf('\n');
```

Scilab code Exa 4.16.1 Example 16

```
clc
clear

//Conditions at 10 bar
P=10;                  //in bar
Tsat=179.9+273;        //in K
Hf=762.8;              //in kJ/kg
Hfg=2015.3;            //in kJ/kg
Hg=2778.1;             //in kJ/kg
Vg=0.194;              //in m^3/kg
```

```
11 x=0.7;                  //Dryness Fraction
12 V=x*Vg;
13 m=0.2/V;                //mass in kg
14 mf=2/V;                 //mass in kg
15 H=Hf+(x*Hfg);
16 H_tot=H*mf;
17 printf('The total enthalpy: %3.1f kJ',H_tot);
18 printf('\n');
19 U=H-(P*100*V);
20 U_tot=U*mf;
21 printf('The internal energy: %3.1f kJ',U_tot);
22 printf('\n');
23 W=P*100*V;
24 W_tot=W*mf;
25 printf('The external work of evaporation: %3.1f kJ',
      W_tot);
26 printf('\n');
```

Scilab code Exa 4.17.1 Example 17

```
1  clc
2  clear
3
4  //Conditions at 10 bar pressure
5  P=10;                   //in bar
6  Tsat=179.9+273;         //in K
7  Tsup=350+273;
8  x=0.9;                  //Dryness Fraction
9  Hf=762.8;               //in kJ/kg
10 Hfg=2015.3;             //in kJ/kg
11 Hg=2778.1;              //in kJ/kg
12 Vg=0.194;               //in m^3/kg
13 Cps=2.1;                //in kJ/kg K
14 Ha=Hg+(Cps*(Tsup-Tsat));
15 Hb=Hf+(x*Hfg);
```

```
16 H_mix=(Ha+Hb)/2;
17 Tsupe=((H_mix-Hg)/Cps)+Tsat;
18 Tsuper=Tsupe-273;
19 printf('Temperature of superheated steam: %3.0f
     Celcius',Tsuper);
20 printf('\n');
```

Scilab code Exa 4.18.1 Example 18

```
1  clc
2  clear
3
4  //Now at 10 bar pressure
5  V=1.5;                  //Volume in m^3
6  P=10;                   //Pressure in bar
7  x=0.91;                 //Dryness fraction
8  Vg=0.194;               //in m^3/kg
9  m=V/Vg;
10
11 Vf=x*Vg;
12 m_f=V/Vf;
13 printf('Amount of water to be placed in container:
     %2.2f kg',m);
14 printf('\n');
15 printf('Mass of water required: %2.2f kg',m_f);
16 printf('\n');
```

Scilab code Exa 4.19.1 Example 19

```
1  clc
2  clear
3
4  //Conditions at 7 bat
```

```
5  P=7;                    //in bar
6  Tsat=165+273;           //in K
7  Hf=697.2;               //in kJ/kg
8  Hfg=2066.3;             //in kJ/kg
9  Hg=2763.5;              //in kJ/kg
10 Vg=0.273;               //in m^3/kg
11 D=0.02;                 //in m
12 vel=17;                 //in m/s
13 Cps=4.187;              //in kJ/kg K
14 Tw1=25;                 //in Celcius
15 Tw2=100;                //in Celcius
16 Vfr=(22/7)*D*D*vel*(1/4)*60;        //Volume flow
      rate in m^3/min
17 x=0.9;                  //Dryness Fraction
18 V=x*Vg;
19
20 Mfr=Vfr/V;              //Mass flow rate
21 printf('The mass flow rate of steam: %2.2f kg/min',
      Mfr);
22 printf('\n');
23 H1=Hf+(x*Hfg);
24 H2=Cps*100;
25 Mw=(Mfr*(H1-H2))/(Cps*(Tw2-Tw1));
26 printf('The mass flow rate of water: %2.2f kg/min',
      Mw);
27 printf('\n');
```

Scilab code Exa 4.20.1 Example 20

```
1  clc
2  clear
3
4  //Conditions at 9 bar
5  P=9;                    //in bar
6  Tsat=175.4+273;         //in K
```

```
Vg=0.215;              //in m^3/kg
Hf=742.8;              //in kJ/kg
Hfg=2031.1;            //in kJ/kg
Hg=2773.9;             //in kJ/kg
T2=250+273;            //in K
x=0.91;                //Dryness Fraction
V1=x*Vg;
V2=0.2696;             //From Steam Table
W=P*100*(V2-V1);
printf('The Work Output: %2.2f kJ/kg',W);
printf('\n');
H1=Hf+(x*Hfg);
H2=2946.3;             //From steam table in kJ/kg
Q=H2-H1;
printf('The heat supplied to steam: %2.2f kJ/kg',Q);
printf('\n');
U=Q-W;
printf('The internal energy of steam increases by:
   %2.2f kJ/kg',U);
printf('\n');
```

Scilab code Exa 4.21.1 Example 21

```
clc
clear

//Conditions at 16 bar
P=16;                      //in bar
Vov=0.015;                 //Volume of Vessel
Mos=0.1;                   //Mass of steam
SV=Vov/Mos;                //Specific Volume
Vg=0.124;                  //in m^3/kg
Tsat=201.4+273;            //in K
Tsup=(SV/Vg)*Tsat;
printf('The temperature of steam: %2.2f K',Tsup);
```

```
13 printf('\n');
14
15 //Now cooling takes place
16 Tsat=191.16;              //From steam table
17 printf('After cooling, temperature of steam: %2.2f K
     ',Tsat);
18 printf('\n');
19
20 //Now cooled to 10 bar pressure
21 P1=16;                    //in bar
22 Vg=0.194;                 //in m^3/kg
23 v=0.15;                   //in m^3/kg
24 x=v/Vg;                   //Dryness Fraction
25
26 //For constant Volume process W=0
27 Hg=2794.0;                //in kJ/kg
28 Hf=762.8;                 //in kJ/kg
29 Hfg=2015.3;               //in kJ/kg
30 Cps=2.1;                  //in kJ/kg K
31 Tsup=300.84;              //in C
32 Tsat=201.4;               //in C
33 H1=Hg+(Cps*(Tsup-Tsat));
34 U1=H1-(P1*100*v);
35 P2=10;                   //in bar
36 H2=Hf+(x*Hfg);
37 U2=H2-(P2*100*v);
38 Q=U2-U1;
39 printf('Heat rejected by system: %2.2f kJ/kg',Q);
40 printf('\n');
```

Scilab code Exa 4.22.1 Example 22

```
1 clc
2 clear
3
```

```
4  //Isothermal process
5  P=10;                        //in bar
6  Tsat=179.9+273;              //in K
7  Vg=0.194;                    //in m^3/kg
8  Hf=762.6;                    //in kJ/kg
9  Hfg=2015.3;                  //in kJ/kg
10 Hg=2778.1;                   //in kJ/kg
11 x1=1;                        //Dryness Fraction
12 Sf=2.139;                    //in kJ/kg K
13 Sfg=4.448;                   //in kJ/kg K
14 Sg=6.623;                    //in kJ/kg K
15 V=0.3;                       //in m^3
16 m=V/Vg;                      //in kg
17 V2=Vg/2;
18 x2=V2/Vg;                    //Dryness Fraction
19 W=P*100*(V2-Vg)*m;
20 printf('Work Done: %2.2f kJ',W);
21 printf('\n');
22 H1=Hg;
23 H2=Hf+(x2*Hfg);
24 Q=m*(H2-H1);
25 printf('Change in Enthalpy: %2.2f kJ',Q);
26 printf('\n');
27 U=(Q-W);
28 printf('Change in total Internal Energy: %2.2f kJ',U
      );
29 printf('\n');
30 S1=Sg;
31 S2=Sf+(x2*Sfg);
32 S=m*(S2-S1);
33 printf('Change in Entropy: %2.2f kJ/K',S);
34 printf('\n');
35
36 //Now for case 2 where PV=C
37 printf('Now for case 2');
38 printf('\n');
39
40 V01=0.097;
```

```
41 V02=0.5*V01;
42 P1=10;                    //in bars
43 P2=(P1*V01)/V02;          //in bars
44
45 //Now at 20 bars
46 Vg1=0.0996;                //in m^3/kg
47 V2=0.097;
48 x2=V2/Vg1;                 //Dryness Fraction
49 Hf=908.8;                  //in kJ/kg
50 Hfg=1890.7;                //in kJ/kg
51 H2=Hf+(x2*Hfg);
52 H=m*(H2-Hg);
53 printf('Change in Enthalpy: %2.2f kJ',H);
54 printf('\n');
55
56 W=m*P1*100*Vg*(log(V02/V01));
57 printf('Total work done: %2.2f kJ',W);
58 printf('\n');
59
60 U=H;                       //as P1 V1= P2 V2
61 Q=U+W;
62 printf('Change in Enthalpy: %2.2f kJ',Q);
63 printf('\n');
64
65 //Now at 20 bar pressure
66 Sf=2.447;                  //in kJ/kg K
67 Sfg=3.894;                 //in kJ/kg K
68 Sg1=6.341;                 //in kJ/kg K
69 S2=Sf+(x2*Sfg);
70 S1=Sg;
71 S=m*(S2-S1)
72 printf('Change in Entropy: %2.3f kJ/K',S);
73 printf('\n');
```

Scilab code Exa 4.23.1 Example 23

```
clc
clear

//Initial conditions at 7 bar pressure
P1=7;                  //in bars
Vg1=0.273;              //in m^3/kg
V1=Vg1;                 //in m^3/kg
Hg1=2763.5;             //in kJ/kg
H1=Hg1;
Tsat=165+273;              //in K
Sf=1.992;              //in kJ/kg K
Sfg=4.716;             //in kJ/kg K
Sg=6.708;              //in kJ/kg K
n=1.1;

//Final conditions at 0.5 bar
P2=0.5;                //in bars
V2=((P1*(V1^1.1))/P2)^(1/1.1);          //using P(V)
   ^1.1=Constant

W=((P1*100*V1)-(P2*100*V2))/(n-1);
printf('Work Done: %3.2f kJ',W);
printf('\n');

Hf2=340.6;                 //in kJ/kg
Hfg2=2305.4;               //in kJ/kg
Vg2=3.24;                  //in m^3/kg
x2=V2/Vg2;                 //Dryness Fraction

H2=Hf2+(x2*Hfg2);

U1=H1-(P1*100*V1);
U2=H2-(P2*100*V2);
U=U2-U1;
printf('Change in Internal Energy: %3.2f kJ/kg',U);
printf('\n');

Q=U+W;                 //From First law of
```

```
    Thermodynamics
printf('Heat Transferred: %3.2f kJ/kg',Q);
printf('\n');

S1=Sg;
//At 0.5 bar
Sf2=1.091;                  //in kJ/kg K
Sfg2=6.503;                 //in kJ/kg K
Sg2=7.594;                  //in kJ/kg K
S2=Sf2+(x2*Sfg2);
S=S2-S1;
printf('Change in Entropy: %3.2f kJ/kg K',S);
printf('\n');
```

Scilab code Exa 4.24.1 Example 24

```
clc
clear

//At state 1
P1=20;                  //in bar
V=2;
Vg1=0.0996;             //in m^3/kg
Tsat1=212.4+273;            //in K
Tsup1=573;              //in K
V1=Vg1*(Tsup1/Tsat1);
m=V/V1;

//At state 2
V2=V1;
Vg2=V2;
P2=16.9;                //From Steam Table

//Calculations
Hg1=2799.5;             //in kJ/kg
```

```
Cps=2.1;                //in kJ/kg K
H1=m*(Hg1+(Cps*(Tsup1-Tsat1)));
U1=H1-(P1*100*V);

Hg2=2795.5;             //in kJ/kg from Steam table
H2=m*Hg2;
U2=H2-(P2*100*V);

Q=U2-U1;
printf('Heat Transferred: %3.1f kJ',Q);
printf('\n');

Sg1=6.341;                  //in kJ/kg K
S1=Sg1+(Cps*log(Tsup1/Tsat1));

S2=6.4022;                 //From Steam Table
S=m*(S2-S1);
printf('Change in Entropy: %3.3f kJ/K',S);
printf('\n');
```

Scilab code Exa 4.25.1 Example 25

```
clc
clear

//For Throttling process, H1=H2
//At 15 bar pressure
P1=15;                      //in bar
Hf1=844.9;                  //in kJ/kg
Hfg1=1947.3;                //in kJ/kg
x1=0.73;                    //Dryness Fraction

//At 1 bar pressure
P2=1;                       //in bar
Hf2=417.5;                  //in kJ/kg
```

```
Hfg2=2258.0;                    //in kJ/kg
Hg2=2675.5;                     //in kJ/kg
H2=2266.4;                      //in kJ/kg

H1=Hf1+(x1*Hfg1);
x2=(H2-Hf2)/Hfg2;

//Now if x1=0.95
H1=Hf1+(0.95*Hfg1);
H2=H1;

//At 1 bar
Hg=2675.5;
Cps=2.1;
x=0.93;                         //New dryness fraction
T=(H2-Hg)/Cps;                  //Temperature difference
Tsat=99;                        //in Celcius
Tsup=Tsat+T;
printf('Temperature of superheated steam: %3.1f
   Celcius',Tsup);
printf('\n');

//Now at 15 bar
Sf=2.315;                       //in kJ/kg K
Sfg=4.130;                      //in kJ/kg K
Sg=6.445;                       //in kJ/kg K
S1=Sf+(x*Sfg);

//Now at 1 bar
Sg1=7.360;                      //in kJ/kg K
S2=Sg1+(Cps*log((Tsup+273)/(Tsat+273)));
S=S2-S1;
printf('Change in Entropy: %3.2f kJ/kg K',S);
printf('\n');
```

Scilab code Exa 4.26.1 Example 26

```
clc
clear

//Heat lost by Steam=Heat gained by water and
   calorimeter

ms=2;                   //in kg
Hf1=697.2;              //in kJ/kg
Hfg1=2066.3;            //in kJ/kg
Hf2=146.7;              //in kJ/kg
T2=35;                  //in Celcius
T1=15;                  //in Celcius
mg=56;                  //in kg
Cpw=4.187;              //in kJ/kg K
H_gained=mg*Cpw*(T2-T1);
x=(((H_gained)/2)+(Hf2-Hf1))/Hfg1;
printf('The dryness fraction is %2.2f ',x);
printf('\n');
```

Scilab code Exa 4.27.1 Example 27

```
clc
clear

//Calculating dryness fraction
Ms=10;
Mw=1;
x=(100*Ms)/(Ms+Mw);
printf('The Dryness Fraction of steam is %2.1f
   percent',x);
printf('\n');
```

Scilab code Exa 4.28.1 Example 28

```
clc
clear

P1=11;                  //in bar
P2=1.1;                 //in bar
T2=130+273;             //in K
Cps=2.1;                //in kJ/kg K

//At 11 bar
Hf1=781.3;              //in kJ/kg
Hfg1=2000.4;            //in kJ/kg

//At 1.1 bar
Hg2=2679.7;             //in kJ/kg
Tsat=102.3+273;         //in K
Tsup=130+273;

//Now for throttling process, H1=H2
H2=Hg2+(Cps*(Tsup-Tsat));
x=((H2-Hf1)*100)/Hfg1;
printf('The dryness fraction of steam: %2.1f',x);
printf('\n');
```

Scilab code Exa 4.29.1 Example 29

```
clc
clear

//Combined seperating and throttling calorimeter
Ms=5;                   //in kg
```

```
Mw=0.5;                 //in kg
Cps=2.1;                //in kJ/kg K
Man=166.8;              //in mm of Hg
Bar=733.6;              //in mm of Hg

x1=Ms/(Ms+Mw);
P=Man+Bar;
P_bar=(1.01325*P)/760;        //Pressure in bar

//From steam table
Hf1=742.8;                  //in kJ/kg
Hfg1=2031.1;                //in kJ/kg
Tsat=104.8+273;             //in K
Tsup=110.3+273;             //in K
Hg=2683.5;                  //in kJ/kg

H2=Hg+(Cps*(Tsup-Tsat));
x2=(H2-Hf1)/Hfg1;
x=x1*x2;
printf('The dryness fraction of steam: %2.3f',x);
printf('\n');
```

Scilab code Exa 4.30.1 Example 30

```
clc
clear

//Combined seperating and throttling calorimeter

Mw=8;                       //in kg
M=63;                       //in kg
Ms=M-Mw;                    //in kg
P1=81.5;                    //Pressure after throttling
   in mm
P2=754;                     //Barometer reading in mm
```

```
11 SD=13.6;                    //Specific Density of Hg
12
13 x1=Ms/(Ms+Mw);              //Dryness Fraction
14 P=(P1/SD)+P2;                //Pressure in mm
15 P=1.01325;                  //Pressure in bar
16
17 //Now at 7.5 bar pressure
18 Hf1=709.2;                  //in kJ/kg
19 Hfg1=2057.0;                //in kJ/kg
20
21 //Now at 1.01325 bar
22 Hg2=2676.0;                 //in kJ/kg
23 Tsat=100+273;               //in K
24 Cps=2.1;                    //in kJ/kg K
25 Tsup=110+273;               //in K
26
27 //For throttling H1=H2
28 H2=Hg2+(Cps*(Tsup-Tsat));
29 x2=(H2-Hf1)/Hfg1;
30
31 x=x1*x2;
32 printf('The dryness fraction of steam: %2.3f',x);
33 printf('\n');
```

Scilab code Exa 4.31.1 Example 31

```
1 clc
2 clear
3
4 //At 9.2 bar pressure
5 x1=0.96;                      //Dryness Fraction
6 Sf1=2.1038;                   //in kJ/kg K
7 Sg1=6.6151;                   //in kJ/kg K
8
9 //At 3.55 bar pressure
```

```
Sf2=1.7327;                    //in kJ/kg K
Sg2=6.9358;                    //in kJ/kg K
Vg2=0.5173;                    //in m^3/kg

//Now at 0.36 bar pressure
Vg3=4.408;                     //in m^3/kg

S1=Sf1+(x1*(Sg1-Sf1));

//As process is adiabatic
S2=S1;

//From steam table, Sg=6.9358 > S2

x2=(S2-Sf2)/(Sg2-Sf2);
V2=x2*Vg2;

//As volume remains constant
V3=V2;
x3=V3/Vg3;
printf('The dryness fraction of steam: %2.3f',x3);
printf('\n');
```

Scilab code Exa 4.32.1 Example 32

```
clc
clear

//At 10 bar pressure
m=1/(0.9*0.194);

Hf1=762.6;                  //in kJ/kg
x1=0.9;                     //Dryness Fraction
Hfg1=2013.6;                //in kJ/kg
H1=Hf1+(x1*Hfg1);
```

```
11
12 Hf2=640.1;                    //in kJ/kg
13 Hfg2=2107.4;                  //in kJ/kg
14 x2=(H1-Hf2)/Hfg2;
15 Vg2=0.375;
16
17 Ms=(1/(x2*Vg2));
18 Vg3=0.462;
19 //Now mass of steam blown off
20 M=m-Ms;
21
22 printf('Mass of steam blown off: %2.3f kg',M);
23 printf('\n');
24
25 V=1;                        //Volume in m^3
26 x3=V/(Ms*Vg3);
27 printf('Dryness fraction of steam: %2.3f ',x3);
28 printf('\n');
```

Scilab code Exa 4.33.1 Example 33

```
1 clc
2 clear
3
4 //At 25 bar pressure
5 P=25;                         //Pressure in bar
6 x=0.8;                        //Dryness fraction
7 Hf=962.1;                     //in kJ/kg
8 Hfg=1841;                     //in kJ/kg
9 Vg=0.0801;                    //in m^3/kg
10 H=Hf+(x*Hfg);
11 printf('Enthalpy: %2.1f kJ/kg',H);
12 printf('\n');
13
14 U=H-(P*100*x*Vg);
```

```
15 printf('Internal Energy: %2.1f kJ/kg',U);
16 printf('\n');
```

Scilab code Exa 4.34.1 Example 34

```
1  clc
2  clear
3
4  Ms=20;            //in kg
5  Mw=2;             //in kg
6  Cps=2.1;          //in kJ/kg K
7  x1=Ms/(Ms+Mw);    //Dryness fraction
8
9  //At 12 bar pressure
10 Hf1=798.6;            //in kJ/kg
11 Hfg1=1986.2;          //in kJ/kg
12
13 //At 1 bar pressure
14 Hg2=2675.5;           //in kJ/kg
15 Tsup=110+273;             //in K
16 Tsat=99+273;              //in K
17
18 //For throttling, H1=H2
19 H2=Hg2+(Cps*(Tsup-Tsat));
20 x2=(H2-Hf1)/Hfg1;
21
22 x=x1*x2;
23 printf('Dryness fraction of steam: %2.4f kJ',x);
24 printf('\n');
```

Scilab code Exa 4.35.1 Example 35

```
1 clc
```

```
clear

V=0.15;                    //in m^3
P=4;                       //in bar
x=0.8;                     //Dryness fraction

//Now at 4 bar pressure
P=4;                       //in bar
Vg=0.463;                  //in m^3/kg

SV=x*Vg;
Mos=V/SV;                  //Mass of Steam

//Now if Volume is 1 m^3

Ms=1/SV;                   //in kg
//At 4 bar pressure
Hf=604.7;                  //in kJ/kg
Hfg=2133.8;                //in kJ/kg
H=Ms*(Hf+(x*Hfg));
printf('Enthalpy of 1 m^3 steam: %2.2f kJ',H);
printf('\n');
```

Scilab code Exa 4.36.1 Example 36

```
clc
clear

P1=9;                  //in bar
P2=1;                  //in bar
T2=115+273;            //in K
m=1.8;                 //in kg
m1=0.2;                //in kg
x1=m/(m+m1);           //Dryness fraction

```

```
11 //Now from steam table
12 Hf=742.8;              //in kJ/kg
13 Hfg=2031.1;            //in kJ/kg
14 Hg=2675.5;             //in kJ/kg
15 Tsat=99+273;           //in K
16 Tsup=115+273;          //in K
17 Cps=2.1;               //in kJ/kg K
18 H2=Hg+(Cps*(Tsup-Tsat));
19 x2=(H2-Hf)/Hfg;
20 x=x1*x2;
21 printf('The dryness fraction: %2.4f kJ',x);
22 printf('\n');
```

Scilab code Exa 4.37.1 Example 37

```
1  clc
2  clear
3
4  m1=0.45;                  //in kg
5  m=7;                      //in kg
6  P1=12;                    //in bar
7  Bar=760;                  //mm of Hg Barometer reading
8  Man=180;                  //mm of Hg Manometer Reading
9  Cps=2.1;                  //in kJ/kg K
10 P=Bar+Man;
11 P2=(P*1.01325)/760;       //Pressure in bar
12 Tsup=140+273;               //in K
13 x1=m/(m+m1);
14
15 //Now at 12 bar pressure
16 Hf=798.6;                 //in kJ/kg
17 Hfg=1986.2;               //in kJ/kg
18
19 //At 1.25 bar pressure
20 Hg=2685.3;                //in kJ/kg
```

```
21 Tsat=106+273;              //in K
22 //For throttling H1=H2
23 H2=Hg+(Cps*(Tsup-Tsat));
24 x2=(H2-Hf)/Hfg;
25
26 x=x1*x2;
27 printf('The dryness fraction: %2.3f ',x);
28 printf('\n');
```

Scilab code Exa 4.38.1 Example 38

```
1  clc
2  clear
3
4  //Case 1
5  P=10;                    //in bar
6  Cps=2.1;                 //in kJ/kg K
7  x=0.85;                  //Dryness fraction
8  Hf=762.8;                //in kJ/kg
9  Hfg=2015.3;              //in kJ/kg
10 Vg=0.194;                //in m^3/kg
11 Hg=2778.1;               //in kJ/kg
12
13 H=Hf+(x*Hfg);
14 printf('Case 1: When x=0.85 \n \n');
15 printf('Enthalpy of steam: %2.2f kJ',H);
16 printf('\n');
17
18 U=H-(P*100*x*Vg);
19 printf('Internal Energy of steam: %2.2f kJ',U);
20 printf('\n');
21
22 //Case 2
23 H=Hg;                    //in kJ/kg
24 printf('\n \nCase 2: When steam is dry and saturated
```

```
    \n \n');
printf('Enthalpy of steam: %2.2f kJ',H);
printf('\n');

U=H-(P*100*Vg);
printf('Internal Energy of steam: %2.2f kJ',U);
printf('\n');

//Case 3
Tsup=300+273;              //in K
Tsat=179.9+273;                 //in K
H=Hg+(Cps*(Tsup-Tsat));
printf('\n \nCase 3: When steam is superheated to
   300 C \n \n');
printf('Enthalpy of steam: %2.2f kJ',H);
printf('\n');

Vsup=(Tsup/Tsat)*Vg;
U=H-(P*100*Vsup);
printf('Internal Energy of steam: %2.2f kJ',U);
printf('\n');
```

Scilab code Exa 4.39.1 Example 39

```
clc
clear

Ms=5;                  //in kg
P=5;                   //in bar
Tsup=250+273;          //in K
Cps=2.1;               //in kJ/kg K
Tf=30;                 //in C
Cpw=4.187;             //in kJ/kg K
H1=Cpw*Tf;

```

```
12 //At 5 bar pressure
13 Tsat=151.9+273;          //in K
14 Hg=2748.7;           //in kJ/kg
15 H2=Hg+(Cps*(Tsup-Tsat));
16 Q=Ms*(H2-H1);
17 printf('Amount of heat required: %2.2f kJ',Q);
18 printf('\n');
```

Scilab code Exa 4.40.1 Example 40

```
1  clc
2  clear
3
4  Ms=3;                  //in kg
5  Tf=30;                 //in C
6  P=8;                   //in bar
7  Tsup=210+273;          //in K
8  Cps=2.1;               //in kJ/kg K
9  Cpw=4.186;             //in kJ/kg K
10
11 H1=Cpw*Tf;
12
13 //At 8 bar pressure
14 Tsat=170.4+273;          //in K
15 Hg=2769.1;               //in kJ/kg
16 H2=Hg+(Cps*(Tsup-Tsat));
17 Q=Ms*(H2-H1);
18 printf('Amount of heat required: %2.2f kJ',Q);
19 printf('\n');
```

Scilab code Exa 4.41.1 Example 41

```
1  clc
```

```
2  clear
3
4  //At 7 bar pressure
5  P1=7;                    //in bar
6  P2=1;                    //in bar
7  n=1.1;
8  //Now according to law of expansion P(V)^1.1=
       Constant
9
10 Vg1=0.273;               //in m^3/kg
11 V1=Vg1;
12 V2=((P1/P2)^(1/n))*V1;
13
14 W=((P1*100*V1)-(P2*100*V2))/(n-1);
15 printf('Work Done: %3.1f kJ/kg',W);
16 printf('\n');
17
18 Hg=2763.5;                //in kJ/kg
19 H1=Hg;
20 Vg=1.694;
21 //At 1 bar, Vg=1.694 and as V2<Vg steam is wet
22 x=V2/Vg;
23
24 Hf=417.5;                 //in kJ/kg
25 Hfg=2258;                 //in kJ/kg
26 H2=Hf+(x*Hfg);
27
28 U2=H2-(P2*100*V2);
29 U1=H1-(P1*100*V1);
30 U=U2-U1;
31 printf('Change in Internal Energy: %3.2f kJ/kg',U);
32 printf('\n');
33
34 Q=U+W;
35 printf('Heat transferred during the process: %3.2f
       kJ/kg',Q);
36 printf('\n');
```

Chapter 5

Steam Boilers

Scilab code Exa 5.1.1 Example 1

```
clc
clear

Mf=1300;                    //in kg
Ma=13000;                   //in kg
P=7;                        //in bar
Cpw=4.187;                  //in kJ/kg K
CV=30000;                   //in kJ/kg
x=0.95;                     //Dryness Fraction
Tfw=40;                     //in C

Hfw=Tfw*Cpw;

//At 7 bar
Hf=697.2;                   //in kJ/kg
Hfg=2066.3;                 //in kJ/kg

H=Hf+(x*Hfg);
Ms=Ma/Mf;

Me=(Ms*(H-Hfw))/(2257);
```

```
22 printf('Equivalent evaporation: %3.2f kg/kg of coal'
      ,Me);
23 printf('\n');
24
25 Eff=100*(Ma*(H-Hfw))/(Mf*CV);
26 printf('Boiler Efficiency: %3.1f Percent',Eff);
27 printf('\n');
```

Scilab code Exa 5.2.1 Example 2

```
1  clc
2  clear
3
4  Ma=5400;                    //in kg/hr
5  Tfw=42;                     //in C
6  P=7.6;                      //in bar
7  Mf=670;                     //in kg/hr
8  x=0.98;                     //Dryness Fraction
9  CV=31000;                   //kJ/kg
10 Ms=Ma/Mf;
11 Hf=175.81;                  //in kJ/kg
12 Hfw=Hf;
13
14 //Now at 7.6 bar pressure
15 Hf=711.8;                   //in kJ/kg
16 Hfg=2055.2;                 //in kJ/kg
17
18 H=Hf+(x*Hfg);
19 Eff=100*(Ma*(H-Hfw))/(Mf*CV);
20 printf('Boiler Efficiency %3.1f percent',Eff);
21 printf('\n');
22
23 Me=(Ms*(H-Hfw))/(2257);
24 printf('Equivalent evaporation: %3.2f kg/kg of coal'
      ,Me);
```

```
25 printf('\n');
```

Scilab code Exa 5.3.1 Example 3

```
1  clc
2  clear
3
4  P=12;                        //in bar
5  CV=34000;                    //in kJ/kg
6  T=250;                       //in C
7  Ms=10;                       //in kg/kg of coal
8  Tfw=36;                      //in C
9  Hfw=150.74;                  //in kJ/kg
10 Hg=2784.8;                   //in kJ/kg
11 Tsup=T;
12 Tsat=188;                    //in C
13 Cps=2.1;                     //in kJ/kg K
14 H=Hg+(Cps*(Tsup-Tsat));
15
16 Me=(Ms*(H-Hfw))/2257;
17 printf('Equivalent evaporation: %3.2f kg/kg of coal'
      ,Me);
18 printf('\n');
19
20 Eff=(Me*250)/21.296;
21 printf('Boiler Power: %3.2f kW',Eff);
22 printf('\n');
```

Scilab code Exa 5.4.1 Example 4

```
1  clc
2  clear
3
```

```
4  Ma=35500;              //kg of steam
5  Mf=3460;
6  CV=39500;
7  Ms=Ma/Mf;
8
9
10 Hfw2=313.9;                //in kJ/kg
11 Hfw1=71.4;                 //in kJ/kg
12
13 Q=Ma*(Hfw2-Hfw1);              //Heat added in
       economizer
14 H=2915.0;              //in kJ/kg
15
16 Me=(Ms*(H-Hfw2))/2257;
17 printf('Equivalent evaporation: %3.2f kg/kg of Oil',
       Me);
18 printf('\n');
19
20 Eff1=(Ma*100*(H-Hfw2))/(Mf*CV);
21 printf('Thermal Efficiency of boiler: %3.1f Percent'
       ,Eff1);
22 printf('\n');
23
24 Eff2=(Ma*100*(H-Hfw1))/(Mf*CV);
25 printf('Thermal Efficiency of Boiler plant: %3.1f
       Percent',Eff2);
26 printf('\n');
27
28 HU=860875000/(Mf*CV);
29 printf('Heat Utilized by Economizer: %3.1f Percent',
       HU);
30 printf('\n');
```

Scilab code Exa 5.5.1 Example 5

```
clc
clear

Ma=10000;              //in kg/hr
P=7;                   //in bar

Tfw=40;                //in C
Hfw=167.6;             //in kJ/kg
H=2763.5;              //in kJ/kg

Q=Ma*(H-Hfw)/60;                //Heat per minute
SA=Q/2720;                      //Heating surface area
   required
printf('Heating surface area required: %3.1f m^2',SA
   );
printf('\n');

GA=SA/25;
printf('Grate area required: %3.1f m^2',GA);
printf('\n');
```

Scilab code Exa 5.6.1 Example 6

```
clc
clear

Ma=2400;               //in kg
Mf=240;                //in kg
P=12;                  //in bar
CV=33500;              //in kJ/kg
Tfw=120;               //in C
Cpw=4.187;
Hfw=Cpw*Tfw;
H=2784.8;              //in kJ/kg
Mfa=Mf-(0.1*Mf);
```

```
13 Eff=(Ma*100*(H-Hfw))/(Mfa*CV);
14 printf('Thermal Efficiency: %3.1f percent',Eff);
15 printf('\n');
16
17 Eff1=(Ma*100*(H-Hfw))/(Mf*CV);
18 printf('Thermal Efficiency of boiler and grate: %3.1
      f percent',Eff1);
19 printf('\n');
```

Scilab code Exa 5.7.1 Example 7

```
1  clc
2  clear
3
4  Mf=255;          //in kg
5  x=0.94;          //Dryness Fraction
6  CV=30100;        //in kJ/kg
7  P=11.5;          //in bar
8  Ma=2100;         //in kg
9  Tfw=25;          //in C
10 Ms=Ma/Mf;
11
12 Hfw=104.9;           //in kJ/kg
13 Hf=790.1;            //in kJ/kg
14 Hfg=1993.2;          //in kJ/kg
15 H=Hf+(x*Hfg);
16
17 Me=(Ms*(H-Hfw))/2257;
18 Eff=(Ma*100*(H-Hfw))/(Mf*CV);
19 printf('Equivalent Evaporation: %3.2f kg/kg of coal
      \n',Me)
20 printf('Thermal Efficiency: %3.1f percent',Eff);
21 printf('\n');
```

Scilab code Exa 5.8.1 Example 8

```
clc
clear

Hf=762.8;                    //in kJ/kg
Hfg=2015.3;                  //in kJ/kg
x=0.95;                      //Dryness Fraction
Ma=1000;
Eff=0.75;
CV=31000;

H=Hf+(x*Hfg);
Cpw=4.187;
T=50;

Hfw=Cpw*T;
Q=Ma*(H-Hfw);

Mf=Q/(Eff*CV);
y=Mf/0.9;

Eff1=(Q*100)/(y*CV);
printf('Efficiency of Boiler and grate: %3.1f
   percent',Eff1);
printf('\n');
```

Scilab code Exa 5.9.1 Example 9

```
clc
clear

```

```
4 //At 10 bar
5 Hg=2778.1;                    //in kJ/kg
6 Cp=2.1;                       //in kJ/kg K
7 T=50;
8 CV=30000;                 //in kJ/kg
9
10 H=Hg+(Cp*T);
11 C=4.187;
12 Tf=30;
13 Hfw=C*Tf;
14
15 Ms=800/100;
16
17 Me=(Ms*(H-Hfw))/2257;
18 printf('Equivalent Evaporation: %3.2f kg/kg of coal'
      ,Me);
19 printf('\n');
20
21 Eff=(Ms*100*(H-Hfw))/CV;
22 printf('Efficiency of Boiler and grate: %3.1f
      percent',Eff);
23 printf('\n');
```

Scilab code Exa 5.10.1 Example 10

```
1 clc
2 clear
3
4 //At 10 bar pressure
5 Tsat=179.9;
6 Tsup=250;
7 Cps=2.1;                      //in kJ/kg K
8
9 Hg=2778.1;                    //in kJ/kg
10 Ms=10;                       //in kg/kg of coal
```

```
11 Hsup=Hg+(Cps*(Tsup-Tsat));
12
13 Hfw=155;
14 Me=(Ms*(Hsup-Hfw))/2257;
15
16 FOE=Me/Ms;              //Factor of Evaporation
17 BP=(Me*370)/21.296;
18 printf('Equivalent Evaporation: %3.1f kg/kg of coal'
      ,Me);
19 printf('\n');
20 printf('Boiler Power: %3.1f kW',BP);
21 printf('\n');
```

Scilab code Exa 5.11.1 Example 11

```
1  clc
2  clear
3
4  Ma=1100;                 //in kg/hr
5  CV=33000;                    //in kJ/kg
6  Tfw=46;                  //in C
7  P=10;               //in bar
8  x=0.9;              //Dryness Fraction
9  Eff=0.81;                //Efficiency
10
11 Hf=762.8;
12 Hfg=2015.3;
13 H=Hf+(x*Hfg);
14 Hfw=192.6;
15
16 Mf=(Ma*(H-Hfw))/(CV*Eff);
17 printf('Amount of Coal Consumed per hour: %3.1f kg',
      Mf);
18 printf('\n');
```

Scilab code Exa 5.12.1 Example 12

```
clc
clear

Ms=7.3;                 //kg/kg of fuel
Tfw=46;                 //in C
P=10;                   //in bar
FOE=1.17;               //Factor of Evaporation
Eff=0.79;
Me=FOE*Ms;
printf('Equivalent Evaporation: %3.2f kg/kg of coal'
   ,Me);
printf('\n');

Hfw=192.6;                  //in kJ/kg
Hg=2778.1;                  //in kJ/kg
Tsat=179.9;                 //in C
Cps=2.1;                    //in kJ/kg K
H=(2257*FOE)+Hfw;
Tsup=((H-Hg)/Cps)+Tsat;
printf('Temperature of Superheated Steam: %3.1f C',
   Tsup);
printf('\n');

CV=(Ms*(H-Hfw))/Eff;
printf('Calorific Value: %3.1f kJ/kg',CV);
printf('\n');
```

Scilab code Exa 5.13.1 Example 13

```
clc
```

```
clear

Ma=18000;                //in kg/hr
P=10;                    //in bar
x=0.97;                  //Dryness Fraction
Tfw=40;                  //in C
Mf=2050;                 //in kg/hr
CV=28000;                //kJ/kg

//At 10 bar
Hf1=762.8;
Hfg1=2015.3;
H=Hf1+(x*Hfg1);

Hfw=167.6;

Eff=(Ma*100*(H-Hfw))/(Mf*CV);
printf('Boiler efficiency: %3.2f Percent',Eff);
printf('\n');

EA=((Ma/Mf)*(H-Hfw))/2257;
printf('Equivalent Evaporation: %3.2f kg/kg of coal'
   ,EA);
printf('\n');
```

Scilab code Exa 5.14.1 Example 14

```
clc
clear

Ma=18000;                //in kg/hr
P=12;                    //in bar
x=0.97;                  //Dryness Fraction
CV=27400;                //in kJ/kg
Mf=2050;                 //in kg>hr
```

```
9
10 Qs=Mf*CV;
11 printf('Heat Supplied per hour: %3.1f kJ/hr',Qs);
12 printf('\n');
13
14 //At 12 bar
15 Hf=798.6;              //in kJ/kg
16 Hfg=1986.2;            //in kJ/kg
17 H1=Hf+(x*Hfg);
18
19 //At 105 C
20 Hfw=438.9;            //in kJ/kg
21 Eff=(Ma*100*(H1-Hfw))/Qs;
22 printf('Thermal Efficiency: %3.2f Percent',Eff);
23 printf('\n');
24
25 Ms=Ma/Mf;
26 printf('Factor of Evaporation: %3.2f ',Ms);
27 printf('\n');
```

Scilab code Exa 5.15.1 Example 15

```
1 clc
2 clear
3
4 Ms=7.5;           //kg/kg of coal
5 P=11;             //in bar
6 Tf=70;            //in C
7 Eff=0.75;         //Efficiency
8 FOE=1.15;         //Factor of Evaporation
9 Cps=2.1;          //in kJ/kg K
10 Hfw=293;         //in kJ/kg
11 H=(FOE*2257)+Hfw;
12
13 //At 11 bar
```

```
14 Hg=2781.7;       //in kJ/kg
15 Tsat=184.1;      //in C
16 Tsup=((H-Hg)/Cps)+Tsat;
17 DOS=Tsup-Tsat;       //Degree of Superheat
18 printf('Degree of Superheat: %3.1f C',DOS);
19 printf('\n');
20
21 Me=(Ms*(H-Hfw))/2257;
22 printf('Equivalent evaporation: %3.2f kg/kg of coal'
      ,Me);
23 printf('\n');
24
25 CV=(Ms*(H-Hfw))/Eff;
26 printf('Calorific value of Boiler: %3.2f kJ/kg ',CV)
      ;
27 printf('\n');
```

Scilab code Exa 5.16.1 Example 16

```
1  clc
2  clear
3
4  Ma=17000;        //in kg/hr
5  P=14;            //in bar
6  x=0.95;          //Dryness Fraction
7  Tfw=102;             //in C
8  Mf=2050;             //in kg/hr
9  CV=27400;        //Calorific Value
10 HS=Mf*CV;
11 printf('Heat Supplied per hour: %3.2f kJ',HS);
12 printf('\n');
13
14 Hf=830.3;            //in kJ/kg
15 Hfg=1959.7;          //in kJ/kg
16 Hfw=427.5;           //in kJ/kg
```

```
17
18 H=Hf+(x*Hfg);
19 Eff=(Ma*100*(H-Hfw))/(Mf*CV);
20 printf('Efficiency of Boiler: %3.2f Percent',Eff);
21 printf('\n');
22
23 Ms=Ma/Mf;
24 Me=(Ms*(H-Hfw))/2257;
25 printf('Equivalent evaporation: %3.2f kg/kg of coal'
      ,Me);
26 printf('\n');
```

Scilab code Exa 5.17.1 Example 17

```
1  clc
2  clear
3
4  Ma=1800;          //kg/hr
5  P=12;             //in bar
6  x=0.97;           //Dryness Fraction
7  Tfw=105;          //in C
8  Mf=2050;          //in kg/hr
9  CV=27400;         //in kJ/kg
10
11 Q=Mf*CV;
12 printf('Heat Supplied: %3.2f kJ',Q);
13 printf('\n');
14
15 //At 12 bar pressure
16 Hf=798.6;              //in kJ/kg
17 Hfg=1986.2;            //in kJ/kg
18 H=Hf+(x*Hfg);
19 Hfw=4.187*Tfw;
20
21 Me=(Ma*(H-Hfw))/(2257*Mf);
```

```
22 printf('Equivalent Evaporation: %3.2f kg/kg of coal'
   ,Me);
23 printf('\n');
24
25 Eff=(Ma*100*(H-Hfw))/(CV*Mf);
26 printf('Efficiency of boiler: %3.2f Percent',Eff);
27 printf('\n');
```

Scilab code Exa 5.18.1 Example 18

```
1  clc
2  clear
3
4  Me=10;       //kg/kg
5  CV=34000          //kJ/kg
6
7  x=Me*2257;
8
9  Eff=100*x/CV;
10 printf('Efficiency of Boiler: %3.2f Percent',Eff);
11 printf('\n');
```

Scilab code Exa 5.19.1 Example 19

```
1  clc
2  clear
3
4  Ma=5500;          //kg/hr
5  P=1;              //bar
6  x=0.94;           //Dryness Fraction
7  Tfw=40;           //in C
8  Mf=600;           //kg/hr
9  CV=32000;         //kJ/kg
```

```
10 Hfw=Tfw*4.187;
11
12 //At 1 bar pressure
13 Hf=417.5;          //kJ/kg
14 Hfg=2258;         //kJ/kg
15 H=Hf+(x*Hfg);
16 Ms=Ma/Mf;
17
18 Me=(Ms*(H-Hfw))/2257;
19 printf('Equivalent Evaporation: %3.3f kg/kg of coal'
      ,Me);
20 printf('\n');
21
22 Eff=(Ms*100*(H-Hfw))/CV;
23 printf('Efficiency: %3.2f percent',Eff);
24 printf('\n');
```

Chapter 6

Heat Engines

Scilab code Exa 6.1.1 Example 1

```
1  clc
2  clear
3
4  m=1;          //in kg
5  R=0.287;      //Universal Gas Constant
6  r=7;          //Compression Ratio
7  P1=1;         //in bar
8  T1=24+273;    //in K
9  T3=2000;      //in K
10 G=1.4;        //Gamma
11
12 ASE=(1-(1/(r)^(G-1)))*100;
13 printf('Air Standard Efficiency is %3.1f Percent',
       ASE);
14 printf('\n');
15
16 P2=P1*(r)^G;
17 printf('Pressure at end of Compression is %3.2f Bar'
       ,P2);
18 printf('\n');
19
```

```
20 T2=T1*((r)^(G-1));
21 printf('Temperature at end of Compression is %3.2f K
     ',T2);
22 printf('\n');
23
24 Cv=0.718;
25 Q=Cv*(T3-T2);
26 printf('Heat Supplied is %3.2f kJ/kg',Q);
27 printf('\n');
28
29 W=ASE*Q/100;
30 V1=(m*R*T1)/(P1*100);
31 V2=V1/r;
32 V=V1-V2;
33 Pm=W/V;
34 printf('Mean Effective Pressure is %3.2f kPa',Pm);
35 printf('\n');
```

Scilab code Exa 6.2.1 Example 2

```
1 clc
2 clear
3
4 T1=323;          //in K
5 T2=673;          //in K
6 G=1.4;
7
8 r_G=T2/T1;
9 r=(r_G)^(1/(G-1));
10 printf('Compression Ratio is %2.2f ',r);
11 printf('\n');
12
13 Eff=100*(1-(1/(r^(G-1))));
14 printf('Air Standard Efficiency is %2.0f Percent ',
     Eff);
```

```
15 printf('\n');
```

Scilab code Exa 6.3.1 Example 3

```
1  clc
2  clear
3
4  P1=97;              //in kPa
5  T1=323;             //in K
6  r=5;                //Compression Ratio
7  Q=930;              //in kJ/kg
8  G=1.4;
9  Cv=0.718;
10 T2=T1*(r^(G-1));
11 T3=(Q/Cv)+T2;
12 printf('Maximum Temperature Attained is %2.2f K',T3)
     ;
13 printf('\n');
14
15 Eff=100*(1-(1/(r)^(G-1)));
16 printf('Thermal Efficiency of cycle is %2.1f Percent
     ',Eff);
17 printf('\n');
18
19 W=Eff*Q/100;
20 printf('Work Done is %2.2f kJ/kg',W);
21 printf('\n');
```

Scilab code Exa 6.4.1 Example 4

```
1  clc
2  clear
3
```

```
T1=57+273;              //in K
T2=603+273;             //in K
T3=1950+273;            //in K
T4=870+273;             //in K
G=1.4;
P1=1;                   //in bar
Cp=1.005;
Cv=0.718;

P2=P1*((T2/T1)^((G)/(G-1)));
printf('Maximum Pressure attained is %2.1f bar',P2);
printf('\n');

Qs=Cp*(T3-T2);              //Heat Supplied
Qr=Cv*(T4-T1);             //Heat Rejected
Eff=100*(1-(Qr/Qs));
printf('Efficiency is %2.0f Percent',Eff);
printf('\n');
```

Scilab code Exa 6.5.1 Example 5

```
clc
clear

V2=0.2;             //in cm^3
V3=V2;
Vc=V2;

Vs=1.2;             //in cm^3
V1=V2+Vs;
G=1.4;

r=(V1/V2);
Eff=100*(1-(1/(r^(G-1))));
printf('Efficiency of Engine is %2.0f Percent',Eff);
```

```
15 printf('\n');
```

Scilab code Exa 6.6.1 Example 6

```
1  clc
2  clear
3
4  rc=14;              //Adiabatic Compression Ratio
5  ra=8;               //Adiabatic Expansion Ratio
6  G=1.4;
7  Z=rc/ra;            //Cutoff Ratio
8
9  //It is a diesel Cycle
10 Eff=100*(1-((1/(rc^(G-1)))*(1/G)*((Z^G)-1)/(Z-1)));
11 printf('Efficiency is %2.1f Percent',Eff);
12 printf('\n');
```

Scilab code Exa 6.7.1 Example 7

```
1  clc
2  clear
3
4  Eff=0.6;            //Efficiency
5  T2=283;             //in K
6  T1=T2/(1-Eff);
7  printf('Initial Temperature is %2.1f K',T1);
8  printf('\n');
```

Scilab code Exa 6.8.1 Example 8

```
clc
clear

D=10;          //Diameter in cm
L=15;          //Length in cm
Vs=(22/7)*(1/4)*D*D*L;        //in cm^3
Vc=250;        //in cm^3
V2=Vc;
V1=Vs+Vc;
r=V1/V2;
G=1.4;

Eff=100*(1-(1/(r^(G-1))));
printf('Efficiency is %2.1f Percent',Eff);
printf('\n');
```

Scilab code Exa 6.9.1 Example 9

```
clc
clear

T3=15+273;        //in K
T4=T3;
P3=1.1;        //in bar
P4=4;          //in bar
P1=12;         //in bar
N=150;         //in rpm
G=1.4;

T1=T4*((P1/P4)^((G-1)/G));
Eff=100*(1-(T4/T1));
printf('The Efficiency is %3.2f Percent',Eff);
printf('\n');

r=P4/P3;
```

```
18 R=0.287;
19 m=1;
20
21 W=m*R*(T1-T3)*(log(r));
22 P=W*(N/60);
23 printf('The Power is %3.1f kW',P);
24 printf('\n');
```

Scilab code Exa 6.10.1 Example 10

```
1  clc
2  clear
3
4  T3=1350+273;          //in K
5  T1=30+273;            //in K
6  Qs=750;           //in kJ/kg
7  Cv=0.718;
8  G=1.4;
9
10 //For Process 2-3
11 T2=T3-(Qs/Cv);
12 r=(T2/T1)^(1/(G-1));
13 printf('The compression Ratio is %3.2f ',r);
14 printf('\n');
15
16 Eff=100*(1-(1/(r^(G-1))));
17 printf('The Efficiency is %3.1f Percent',Eff);
18 printf('\n');
19
20 W=Eff*Qs/100;
21 printf('The Work Output is %3.0f kJ/kg',W);
22 printf('\n');
23
24 P21=(r^G);
25 P32=T3/T2;
```

```
26 P31=P21*P32;
27 printf('Ratio of maximum to minimum pressure is %3.2
      f ',P31);
28 printf('\n');
```

Scilab code Exa 6.11.1 Example 11

```
1  clc
2  clear
3
4  Vs=500;          //in cm^3
5  Vc=55;           //in cm^3
6  T1=30+273;       //in K
7  P1=1;            //in bar
8  T3=1450+273;         //in K
9  G=1.4;
10 R=0.287;
11 Cv=0.718;
12 r=(Vs+Vc)/Vc;
13 Eff=100*(1-(1/(r^(G-1))));
14 printf('The standard air Efficiency is %3.2f Percent
      ',Eff);
15 printf('\n');
16
17 T2=T1*(r^(G-1));
18 Qs=Cv*(T3-T2);
19 W=Eff*Qs;
20
21 V1=Vc+Vs;
22 m=(P1*100*V1*(10^-6))/(R*T1);
23 Pm=(W*m)/(100*(Vs*(10^-6)));
24 printf('The Mean Effective Pressure is %3.1f kPa',Pm
      );
25 printf('\n');
```

Scilab code Exa 6.12.1 Example 12

```
clc
clear

r=6;          //Compression Ratio
T1=20+273;    //in K
G=1.4;
Cv=0.718;
Qs=1900;
Eff=100*(1-(1/(r^(G-1))));
printf('The Efficiency is %3.2f Percent',Eff);
printf('\n');

T2=T1*(r^(G-1));
printf('The value of T2 is %3.0f K',T2);
printf('\n');

T3=(Qs/Cv)+T2;
printf('The value of T3 is %3.0f K',T3);
printf('\n');

T4=T3/(r^(G-1));
printf('The value of T4 is %3.0f K',T4);
printf('\n');

W=Qs*Eff/100;
printf('The Work Output is %3.0f kJ/kg',W);
printf('\n');
```

Scilab code Exa 6.13.1 Example 13

```
clc
clear

D=0.1;          //Diameter
L=0.12;         //Length
V=(22/7)*(1/4)*D*D*L;
T1=19+273;
r=6.5;          //Compression ratio
P1=1;           //in bar
G=1.4;          //Gamma
Vs=9.425*(10^-4);
Vc=Vs/(r-1);
V1=Vc+Vs;
printf('V1= %3.5f m^3',V1);
printf('\n');

V2=Vc;
V3=Vc;
P2=P1*(r^G);
printf('P2= %3.1f bar',P2);
printf('\n');

T2=T1*(r^(G-1));
printf('T2= %3.1f K',T2);
printf('\n');

//For process 2-3
Qs=1900;
Cv=0.718;
T3=(Qs/Cv)+T2;
printf('T3= %3.1f K',T3);
printf('\n');

P3=P2*(T3/T2);
printf('P3= %3.1f bar',P3);
printf('\n');

//For process 4-1
```

```
39 V4=V1;
40 P4=P3*((V3/V4)^G);
41 printf('P4= %3.1f bar',P4);
42 printf('\n');
43
44 T4=T1*(P4/P1);
45 printf('T4= %3.1f K',T4);
46 printf('\n');
47
48 Eff=100*(1-(1/(r^(G-1))));
49 printf('Efficiency= %3.1f Percent',Eff);
50 printf('\n');
51
52 R=0.287;
53 m=(P1*100*V1)/(R*T1);
54 Pm=(Eff*Qs*m)/(10000*Vs);
55 printf('Mean Effective Pressure= %3.1f bar',Pm);
56 printf('\n');
```

Scilab code Exa 6.14.1 Example 14

```
1 clc
2 clear
3
4 P1=1;          //in bar
5 T1=20+273;        //in K
6 P2=39;         //in bar
7 P3=P2;
8 T3=1100+273;          //in K
9 G=1.4;
10
11 //For reversible Adiabatic Process 1-2
12 T2=T1*((P2/P1)^((G-1)/G));
13 r=(P2/P1)^(1/G);
14
```

```
15 Z=T3/T2;
16
17 Eff=100*(1-((1/(r^(G-1)))*(1/G)*((Z^G)-1)/(Z-1)));
18 printf('Efficiency: %2.2f Percent',Eff);
19 printf('\n');
```

Scilab code Exa 6.15.1 Example 15

```
1  clc
2  clear
3
4  r=16;          //Compression Ratio
5  D=0.21;        //Diameter
6  L=0.3;         //Length
7  P1=1;          //in bar
8  G=1.4;
9  T1=17+273;     //in K
10 Z=[0.1*(r-1)+1];
11 Vs=(22/7)*(1/4)*D*D*L;
12 Vc=Vs/15;
13 V2=Vc;
14 printf('Vc= V2= %2.6f m^3',Vc);
15 printf('\n');
16 V1=Vc+Vs;
17 printf('V1= %2.4f m^3',V1);
18 printf('\n');
19 V3=(0.1*(Vs))+(V2);
20 printf('V3= %2.4f m^3',V3);
21 printf('\n');
22
23 //For Process 1-2
24 P2=r^G;
25 printf('P2= %2.1f bar',P2);
26 printf('\n');
27
```

```
28 T2=T1*(r^(G-1));
29 printf('T2= %2.1f K',T2);
30 printf('\n');
31
32 T3=Z*T2;
33 printf('T3= %2.1f K',T3);
34 printf('\n');
35
36 P3=P2;
37 P4=P3*((V3/V1)^G);
38 printf('P4= %2.1f bar',P4);
39 printf('\n');
40
41 T4=T3*((V3/V1)^(G-1));
42 printf('T4= %2.1f K',T4);
43 printf('\n');
44
45 Cv=0.718;
46 Cp=1.005;
47
48 Eff=100*(1-((Cv*(T4-T1))/(Cp*(T3-T2))));
49 printf('Efficiency: %2.1f Percent',Eff);
50 printf('\n');
51
52 R=0.287;
53 m=(P1*100*V1)/(R*T1);
54 Pm=(m*((Cp*(T3-T2))-(Cv*(T4-T1))))/(Vs);
55 printf('Mean Effective Pressure= %2.1f kPa',Pm);
56 printf('\n');
57
58 N=300;          //Cycles per minute
59 W=10.41;
60 EP=W*(N/60);
61 printf('Engine Power= %2.2f kW',EP);
62 printf('\n');
```

Scilab code Exa 6.16.1 Example 16

```
clc
clear

r=19;          //Compression Ratio
P1=1;          //in bar
T1=17+273;     //in K
Qs=730;        //in kJ/cycle
G=1.4;

//For process 1-2
m=1;           //in kg
R=0.287;       //Universal Gas Constant
V1=(m*R*T1)/(P1*100);
printf('V1= %2.4f m^3/kg',V1);
printf('\n');

V2=V1/r;
printf('V2= %2.4f m^3/kg',V2);
printf('\n');

P2=P1*(r^G);
printf('P2= %2.1f bar',P2);
printf('\n');

T2=T1*(r^(G-1));
printf('T2= %2.1f K',T2);
printf('\n');

//For Process 2-3
Cv=0.718;
T3=(Qs/(Cv*m))+T2;
printf('T3= %2.1f K',T3);
```

```
printf('\n');

P3=P2;
printf('P3= %2.1f bar',P3);
printf('\n');

//As pressure is constant
V3=(T3/T2)*V2;
printf('V3= %2.4f m^3/kg',V3);
printf('\n');

//For process 3-4
V4=V1;
T4=T3*((V3/V4)^(G-1));
printf('T4= %2.1f K',T4);
printf('\n');

P4=P3*((V3/V4)^G);
printf('P4= %2.2f bar',P4);
printf('\n');

Cp=1.005;

W=((Cp)*(T3-T2))-((Cv*(T4-T1)));
printf('Work Done= %2.1f kJ/kg',W);
printf('\n');

Eff=100*(W/(Cp*(T3-T2)));
printf('Efficiency= %2.2f Percent',Eff);
printf('\n');

Pm=W/(V1-V2);
printf('Mean Effective Pressure= %2.2f kPa',Pm);
printf('\n');
```

Scilab code Exa 6.17.1 Example 17

```
clc
clear

r=19;          //Compression Ratio
Re=9.1;        //Expansion Ratio
Z=r/Re;
G=1.4;
Eff=100*(1-((1/(r^(G-1)))*(1/G)*((Z^G)-1)/(Z-1)));
printf('Efficiency: %2.2f Percent',Eff);
printf('\n');
```

Scilab code Exa 6.18.1 Example 18

```
clc
clear

D=16;          //in cm
L=24;          //in cm
Vc=340;
V2=Vc;
G=1.4;

Vs=(22/7)*(1/4)*D*D*L;
V1=Vs+Vc;
r=V1/V2;

//Cut-off is 6% of the stroke
Co1=0.06;

V3=(Co1*(V1-V2))+V2;
Z=V3/V2;
x=(Z^G)-1;
y=(r^(G-1))*(G)*(Z-1);
```

```
21 Eff1=100*(1-((x)/(y)));
22
23
24
25 //Cut-off is 10% of the stroke
26 Co2=0.10;
27
28 V3=(Co2*(V1-V2))+V2;
29 Z=V3/V2;
30 x=(Z^G)-1;
31 y=(r^(G-1))*(G)*(Z-1);
32 Eff2=100*(1-((x)/(y)));
33
34 Loss=((Eff1-Eff2)*100)/Eff1;
35
36 printf('Loss: %2.2f Percent',r);
37 printf('\n');
```

Scilab code Exa 6.20.1 Example 20

```
1 clc
2 clear
3
4 T3=1000+273;          //in K
5 T1=27+273;            //in K
6 G=1.25;
7
8 r=(T3/T1)^G;
9 printf('Compression Ratio: %2.1f ',r);
10 printf('\n');
11
12 T2=sqrt(T1*T3);
13 T4=T2;
14 printf('T2=T4= %2.0f K',T2);
15 printf('\n');
```

```
16
17 Cv=0.718;
18 W=Cv*[(sqrt(T3))-(sqrt(T1))]^2;
19 printf('Maximum Work Done: %2.0f kJ/kg',W);
20 printf('\n');
```

Scilab code Exa 6.21.1 Example 21

```
1  clc
2  clear
3
4  r=6;          //Compression Ratio
5  G=1.4;
6
7  Eff=100*(1-(1/(r^(G-1))));
8  printf('Efficiency: %2.2f Percent',Eff);
9  printf('\n');
10
11 m=1;              //in kg
12 R=0.287;          //Universal Gas Constant
13 T1=27+273;        //in K
14 P1=1;           //in bar
15
16 V1=(m*R*T1)/(P1*100);
17 V2=V1/r;
18 Vc=V2;
19 Vs=V1-Vc;
20
21 T2=T1*(r^(G-1));
22 Cv=0.718;
23 Qs=1046;
24 T3=(Qs/Cv)+T2;
25 T4=T3/(r^(G-1));
26 W=Qs-(Cv*(T4-T1));
27 Pm=W/Vs;
```

```
28 printf('Effective Mean Pressure: %2.2f kPa',Pm);
29 printf('\n');
```

Scilab code Exa 6.22.1 Example 22

```
1  clc
2  clear
3
4  T1=87+273;        //in K
5  r=14;         //Compression Ratio
6  T3=1795+273;          //in K
7  T4=677+273;       //in K
8  G=1.4;
9  T2=T1*(r^(G-1));
10 printf('T2= %2.1f K',T2);
11 printf('\n');
12
13 Cp=1.005;
14 Cv=0.718;
15 W=[Cp*(T3-T2)]-[Cv*(T4-T1)];
16 Qs=Cp*(T3-T2);
17 Eff=(W*100)/Qs;
18 printf('Efficiency: %2.1f Percent',Eff);
19 printf('\n');
```

Scilab code Exa 6.23.1 Example 23

```
1  clc
2  clear
3
4  r=16;         //Compression Ratio
5  P1=1;         //in bar
6  T1=20+273;        //in K
```

```
T3=1431+273;          //in K
G=1.4;
T2=T1*[r^(G-1)];
m=1;
R=0.287;
V1=(m*R*T1)/(P1*100);
V2=V1/r;

//For Constant Pressure Process 2-3
V3=V2*(T3/T2);
Z=V3/V2;
Eff=100*(1-((1/(r^(G-1)))*(1/G)*((Z^G)-1)/(Z-1)));
printf('Efficiency is %2.1f Percent',Eff);
printf('\n');

Cp=1.005;
Qs=Cp*(T3-T2);
W=Qs*Eff/100;
Vs=V1-V2;
Pm=W/Vs;
printf('Effective Mean Pressure %2.1f kPa',Pm);
printf('\n');
```

Scilab code Exa 6.24.1 Example 24

```
clc
clear

r=8;
T1=310;      //in K
T3=1600;          //in K
G=1.4;
Cv=0.717;

//For process 1-2
```

```
11 T2=T1*(r^(G-1));
12
13 //Now Heat Supplied
14 Qs=Cv*(T3-T2);
15 printf('Heat Supplied= %2.1f kJ/kg',Qs);
16 printf('\n');
17
18 //Efficiency of Cycle
19 Eff=100*[1-(1/(r^(G-1)))];
20 printf('Efficiency is %2.1f Percent',Eff);
21 printf('\n');
```

Scilab code Exa 6.25.1 Example 25

```
1 clc
2 clear
3
4 r=15;          //Compression Ratio
5 P1=100;        //in kPa
6 T1=27+273;
7 Cp=1.006;
8 Cv=0.717;
9 G=1.4;
10
11 //Cut off takes place at 12% of Working Stroke
12 T2=T1*(r^(G-1));
13 printf('T2= %2.1f K',T2);
14 printf('\n');
15
16 P2=P1*(r^G);
17 printf('P2= %2.1f kPa',P2);
18 printf('\n');
19
20 Z=(0.12*(r-1))+1;
21 Eff=100*(1-((1/(r^(G-1)))*(1/G)*((Z^G)-1)/(Z-1)));
```

```
22 printf('Efficiency is %2.1f Percent',Eff);
23 printf('\n');
```

Scilab code Exa 6.26.1 Example 26

```
1  clc
2  clear
3
4  T1=288;      //in K
5  T3=1673;         //in K
6  Qs=800;      //in kJ/kg
7  G=1.4;
8  Cv=0.718;
9  R=0.287;
10 P1=1;
11
12 Cp=Cv*G;
13 T2=T3-(Qs/Cp);
14
15 x=T2/T1;
16 r=x^(1/(G-1));
17 printf('Compression Ratio %2.1f ',r);
18 printf('\n');
19
20 Eff=100*[1-(1/(r^(G-1)))];
21 printf('Efficiency is %2.1f Percent',Eff);
22 printf('\n');
23
24 P3=r*T3*P1/T1;
25 printf('P3= %2.1f bar',P3);
26 printf('\n');
```

Scilab code Exa 6.27.1 Example 27

```
clc
clear

T2=293;      //in K
Eff=0.7;
T1=T2/(1-Eff);
printf('T1= %2.1f K',T1);
printf('\n');
```

Scilab code Exa 6.28.1 Example 28

```
clc
clear

T1=330;      //in K
T2=876;      //in K
T3=2223;         //in K
T4=1143;         //in K
P1=1;        //in bar
G=1.4;

Cv=0.718;
Cp=1.005;
Eff=100*[1-((Cv*(T4-T1))/(Cp*(T3-T2)))];
printf('Efficiency is %2.1f Percent',Eff);
printf('\n');

//For Process 1-2
P2=P1*[(T2/T1)^(G/(G-1))];
printf('Maximum Pressure %2.1f bar',P2);
printf('\n');
```

Scilab code Exa 6.29.1 Example 29

```
clc
clear

T1=25+273;        //in K
T3=1500+273;          //in K
Qa=900;       //in kJ/kg
Cv=0.718;
G=1.4;

T2=T3-(Qa/Cv);
r=(T2/T1)^(1/(G-1));
printf('Compression Ratio is %2.1f ',r);
printf('\n');

Eff=100*[1-(1/(r^(G-1)))];
printf('Efficiency is %2.1f Percent',Eff);
printf('\n');

Px=r^G;       //Max Pressure
Py=T3/T2;         //1/Min Pressure
P=Px*Py;
printf('Pressure Ratio %2.1f ',P);
printf('\n');
```

Scilab code Exa 6.30.1 Example 30

```
clc
clear

P1=1;         //in bar
T1=15+273;        //in K
P2=15;        //in bar
P3=40;        //in bar
G=1.4;
Cv=0.718;
```

```
10
11 r=(P2/P1)^(1/G);
12 printf('Compression Ratio is %2.1f ',r);
13 printf('\n');
14
15 Eff=100*[1-(1/r^(G-1))];
16 printf('Efficiency is %2.1f Percent',Eff);
17 printf('\n');
18 T2=T1*(r^(G-1));
19 T3=T2*(P3/P2);
20 T4=T3/(r^(G-1));
21 W=Cv*[T3-T2+(T1-T4)];
22
23 R=0.287;
24 V1=(R*T1)/P1;
25 V2=V1/r;
26
27 Pm=W/(V1-V2);
28 printf('Mean Effective Pressure %2.1f bar',Pm);
29 printf('\n');
```

Scilab code Exa 6.31.1 Example 31

```
1 clc
2 clear
3
4 P2=44;       //in bar
5 P3=P2;
6 T3=1600+273;         //in K
7 P1=1;        //in bar
8 T1=27+273;       //in K
9 G=1.4;
10
11 T2=T1*[(P2/P1)^((G-1)/G)];
12 R=0.287;
```

```
13
14 V1=(R*T1)/(P1*100);
15
16
17 r=(P2/P1)^(1/G);
18 Z=T3/T2;
19 Eff=100*(1-((1/(r^(G-1)))*(1/G)*((Z^G)-1)/(Z-1)));
20 printf('Efficiency is %2.1f Percent',Eff);
21 printf('\n');
```

Scilab code Exa 6.32.1 Example 32

```
1 clc
2 clear
3
4 r=16;          //Compression Ratio
5 P1=1;          //in bar
6 T1=20+273;
7 T3=1431+273;          //in K
8 G=1.4;
9
10 T2=T1*(r^(G-1));
11 Z=T3/T2;
12 T4=(Z^G)*T1;
13 Eff=100*[1-((T4-T1)/(G*(T3-T2)))];
14 printf('Efficiency is %2.1f Percent',Eff);
15 printf('\n');
16
17 Cp=1.005;
18 Qs=Cp*(T3-T2);
19 W=Eff*(Qs/100);
20 R=0.287;
21 V1=(R*T1)/(P1*100);
22 V2=V1/r;
23 V=V1-V2;
```

```
24
25 Pm=W/(V);
26 printf('Mean Effective Pressure %2.1f kPa',Pm);
27 printf('\n');
```

Scilab code Exa 6.33.1 Example 33

```
1  clc
2  clear
3
4  P1=1;          //in bar
5  T1=15+273;        //in K
6  P2=15;         //in bar
7  P3=40;         //in bar
8  G=1.4;
9
10 r=(P2/P1)^(1/G);
11 Eff=100*[1-(1/(r^(G-1)))];
12 printf('Efficiency is %2.1f Percent',Eff);
13 printf('\n');
14
15 T2=T1*[(P2/P1)^((G-1)/G)];
16 T3=T2*(P3/P2);
17 Cv=0.718;
18
19 Qs=Cv*(T3-T2);
20 W=Eff*Qs;
21 R=0.287;
22
23 V1=(R*T1)/(P1*100);
24 V2=V1/r;
25
26 Vs=V1-V2;
27 Pm=W/(Vs*100);
28
```

```
29 printf('Mean Effective Pressure is %2.1f kPa',Pm);
30 printf('\n');
```

Chapter 7

Internal Combustion Engines

Scilab code Exa 7.1.1 Example 1

```
1  clc
2  clear
3
4  Vs=0.01;        //in m^3
5  Pm=600;       //in kPa
6  N=300;        //in rpm
7  n=N/2;
8  IP=(Vs*Pm*n)/60;
9  printf('Indicated Power= %2.0f kW',IP);
10 printf('\n');
```

Scilab code Exa 7.2.1 Example 2

```
1  clc
2  clear
3
4  n=6;          //Number of Cylinders
5  IP=90;        //Indicated Power in kW
```

```
Eff=0.85;          //Mechanical Efficiency
Pmb=5;         //in bar
LD=1.5;
Pm=Pmb/Eff;
N=800;
nx=N/2;

//Length=1.5*D
D=[[IP*60*4]/[Pm*100*(22/7)*LD*nx*n]]^(1/3);
printf('D= %3.4f mm',D*100);
printf('\n');
L=D*LD;
printf('L= %3.4f mm',L*100);
printf('\n');
```

Scilab code Exa 7.3.1 Example 3

```
clc
clear

BP=22;         //Brake Power
Eff=0.85;          //Mechanical Efficiency
IP=BP/Eff;
mf=6.5;
CV=30000;          //Calorific Value
Ebth=BP/((mf/3600)*CV);
printf('Brake Thermal Eff= %3.1f Percent',Ebth*100);
printf('\n');

Eith=IP/((mf/3600)*CV);
printf('Indicated Thermal Eff= %3.1f Percent',Eith
   *100);
printf('\n');

BSFC=mf/BP;
```

```
18 printf('BSFC= %3.1f kg/kWh',BSFC);
19 printf('\n');
```

Scilab code Exa 7.4.1 Example 4

```
1  clc
2  clear
3
4  BP=185;       //Brake Power
5  Eff=0.75;
6  IP=BP/Eff;
7  LD=1.5;
8  N=35;
9  n=N/2;
10 nx=4;
11 Pm=830;       //in kPa
12 D=[[IP*4]/[Pm*(22/7)*LD*nx*n]]^(1/3);
13 printf('D= %3.0f mm',D*1000);
14 printf('\n');
15 L=D*LD;
16 printf('L= %3.0f mm',L*1000);
17 printf('\n');
```

Scilab code Exa 7.5.1 Example 5

```
1 clc
2 clear
3
4 Vc=5*(10^-4);
5 D=0.15;
6 L=0.2;
7 Vs=(22/7)*D*D*L*(1/4);
8 r=(Vc+Vs)/Vc;
```

```
G=1.4;
Ea=[1-(1/(r^(G-1)))];
Eith=0.3;
Erel=Eith/Ea;
printf('Erel= %3.2f Percent',Erel*100);
printf('\n');

Pm=500;      //in kPa
n=1000/2;
IP=(Pm*Vs*n)/60;
printf('IP= %3.2f kW',IP);
printf('\n');
```

Scilab code Exa 7.6.1 Internal Combustion Engines

```
clc
clear

Pm=600;
A=(22/7)*(1/4)*0.11*0.11*0.14;
n=1000;
IP=(Pm*A*n)/60;
Em=0.8;
BP=Em*IP;
printf('BP= %3.2f kW',BP);
printf('\n');
```

Scilab code Exa 7.7.1 Example 7

```
clc
clear

r=6;
```

```
5  G=1.4;
6  Ea=100*[1-(1/(r^(G-1)))];
7  Ebt=Ea/2;
8  CV=41500;
9  BP=15;
10 Mf=BP/(CV*(Ebt/100));
11 printf('Mf= %3.2f kg/hr',Mf*3600);
12 printf('\n');
```

Scilab code Exa 7.8.1 Example 8

```
1  clc
2  clear
3
4  n=4;
5  ;
6
7  DL=1.2;
8  BP=32;
9  N=2500;
10 Pm=9;
11 Em=0.86;
12 Mf=9;
13 CV=43000;
14
15 IP=BP/Em;
16 D=[[IP*60*4]/[Pm*100*(22/7)*DL*N*n]]^(1/3);
17 printf('D= %3.0f mm',D*1000);
18 printf('\n');
19
20 L=DL*D;
21 printf('L= %3.0f mm',L*1000);
22 printf('\n');
23
24 Ebth=BP/(Mf*CV/3600);
```

```
25 printf('Ebth= %3.2f  Percent',Ebth*100);
26 printf('\n');
27
28 Eith=Ebth/Em;
29 printf('Eith= %3.2f  Percent',Eith*100);
30 printf('\n');
```

Scilab code Exa 7.9.1 Example 9

```
1  clc
2  clear
3
4  Eith=0.29;
5  Em=0.77;
6  BP=5.5;
7  SG=0.87;
8  CV=43000;
9  Ebth=Em*Eith;
10 Mf=(BP*3600)/(Ebth*CV);
11 D=SG*1000;
12 Mff=(Mf*1000)/D
13 printf('Mf= %3.2f  litre/hr',Mff);
14 printf('\n');
```

Scilab code Exa 7.10.1 Example 10

```
1  clc
2  clear
3
4  D=16;
5  L=19;
6  Vc=700;
7  Pm=5;
```

```
N=1000;
Eith=0.32;
Vs=(22/7)*D*D*L*(1/4);
Vc=700;
G=1.4;
r=(Vs+Vc)/Vc;
Ea=[1-(1/(r^(G-1)))];
Er=Eith/Ea;
printf('Relative Efficiency= %3.2f Percent',Er*100);
printf('\n');

IP=(Pm*100*Vs*(10^-6)*N)/60;
printf('IP= %3.2f KW',IP);
printf('\n');
```

Scilab code Exa 7.11.1 Example 11

```
clc
clear

T=50;
Vst=870;
N=300;
Pm=10;
n=N/2;

BP=(2*(22/7)*N*T)/(60*1000);
IP=(Pm*100*Vst*(10^-6)*N)/(60*2);
Em=BP/IP;
printf('Mechanical Efficiency= %3.2f Percent',Em
   *100);
printf('\n');
```

Scilab code Exa 7.12.1 Example 12

```
clc
clear

Pm=7;
A=(22/7)*(1/4)*((0.15/1.25)^2);
n=900;
L=0.15;
N=2
IP=(Pm*100*A*L*n*N)/(60*2);
printf('IP= %3.2f kW',IP);
printf('\n');
```

Scilab code Exa 7.13.1 Example 13

```
clc
clear

N=900;
D=0.1;
L=0.14;
Mf=2.1;
CV=42000;
Pm=7.5;
Vc=0.15;
G=1.4;
A=(22/7)*(1/4)*D*D;
IP=(Pm*100*A*L*N*2)/(60*2);
Eith=(IP*3600)/(Mf*CV);
printf('Eith= %3.1f Percent',Eith*100);
printf('\n');

r=(1+0.15)/(0.15);
Ea=1-[1/(r^(G-1))];
```

```
20 Er=Eith/Ea;
21 printf('Relative Efficiency= %3.2f Percent',Er*100);
22 printf('\n');
```

Scilab code Exa 7.14.1 Example 14

```
1  clc
2  clear
3
4  NOC=6;
5  N=820;
6  n=N/2;
7  IP=90;
8  LD=1.4;
9  Pbm=5;
10 Em=0.79;
11 BP=IP*Em;
12 D=[[IP*60*2]/[Pbm*100*(22/7)*(1/4)*LD*N*NOC]]^(1/3);
13 printf('D= %3.0f mm',D*1000);
14 printf('\n');
15 L=LD*D;
16 printf('L= %3.0f mm',L*1000);
17 printf('\n');
```

Scilab code Exa 7.15.1 Example 15

```
1 clc
2 clear
3
4 NOC=4;
5 N=2500;
6 n=N/2;
7 BP=200;
```

```
LD=1.2;
Pm=10;
Em=0.81;
Mf=65;
CV=42000;
IP=BP/Em;
D=[[IP*60*2*4]/[Pm*100*(22/7)*(1.2*(N)*NOC)]]^(1/3);
printf('D= %3.0f mm',D*1000);
printf('\n');

L=LD*D;
printf('L= %3.0f mm',L*1000);
printf('\n');

Eith=(IP*3600)/(Mf*CV);
printf('Eith= %3.2f Percent',Eith*100);
printf('\n');

Ebth=Eith*Em;
printf('Ebth= %3.2f Percent',Ebth*100);
printf('\n');
```

Scilab code Exa 7.16.1 Example 16

```
clc
clear

IP=42;
FP=7;
ES=1800;

BP=IP-FP;

Em=BP/IP;
printf('Mechanical Efficiency= %3.0f Percent',Em
```

```
    *100);
printf('\n');

BSFC=0.3;
CV=43000;

Ebth=3600/(BSFC*CV);
printf('Brake Thermal Efficiency= %3.0f Percent',
    Ebth*100);
printf('\n');

Eith=Ebth/Em;
printf('Indicated Thermal Efficiency= %3.0f Percent'
    ,Eith*100);
printf('\n');
```

Scilab code Exa 7.17.1 Example 17

```
clc
clear

D=0.3;
L=0.45;
N=300;
Pimep=6;
F=1.5;
Reff=(180+4)/2;

IP=(Pimep*100*L*(22/7)*(1/4)*(D*D)*N)/(2*60);
printf('Indicated Power= %3.2f kW',IP);
printf('\n');

BP=(2*(22/7)*N*F*Reff)/6000;
printf('Brake Power= %3.2f kW',BP);
printf('\n');
```

```
18
19 Em=BP/IP;
20 printf('Mechanical Efficiency= %3.2f Percent',Em
      *100);
21 printf('\n');
```

Scilab code Exa 7.18.1 Example 18

```
1  clc
2  clear
3
4  D=0.27;
5  L=0.38;
6  Pmep=6;
7  N=250;
8  F=1000;
9  Reff=0.75;
10 Mf=10;
11 CV=44400;
12
13 BP=(2*(22/7)*N*(F*Reff))/60;
14 printf('Brake Power= %3.2f kW',BP/1000);
15 printf('\n');
16
17 A=(22/7)*(1/4)*(D*D);
18 IP=[Pmep*100*L*A*N]/(2*60);
19 printf('Indicated Power= %3.2f kW',IP);
20 printf('\n');
21
22 Em=BP/(IP*1000);
23 printf('Mechanical Efficiency= %3.2f Percent',Em
      *100);
24 printf('\n');
25
26 Eith=(IP*3600)/(Mf*CV);
```

```
27 printf('Indicated Thermal Power= %3.2f Percent',Eith
      *100);
28 printf('\n');
```

Scilab code Exa 7.19.1 Example 19

```
1  clc
2  clear
3
4  NOC=6;
5  IP=89.5;
6  N=800;
7  LD=1.25;
8  Em=0.8;
9  Pbemp=5;
10 Em=0.8;
11 Pimep=Pbemp/0.8;
12
13 D3=(IP*2*60*4)/(Pimep*100*LD*(22/7)*N*NOC);
14 D=D3^(1/3);
15 L=LD*D;
16 printf('L= %3.0f mm',L*1000);
17 printf('\n');
18 printf('D= %3.0f mm',D*1000);
19 printf('\n');
```

Scilab code Exa 7.20.1 Example 20

```
1 clc
2 clear
3
4 D=0.25;
5 L=0.4;
```

```
6  Pm=6.5;
7  N=250;
8  W=1080;
9  Ddrum=1.5;
10 Mf=10;
11 CV=44300;
12
13 A=(22/7)*(1/4)*D*D;
14 IP=(Pm*100*A*L*N)/(60*2);
15 printf('Indicated Power= %3.2f kW',IP);
16 printf('\n');
17
18 Reff=Ddrum/2;
19 W=1.08;
20
21 BP=[2*(22/7)*N*W*Reff]/60;
22 printf('Brake Power= %3.2f kW',BP);
23 printf('\n');
24
25 Em=BP/IP;
26 Eith=(IP*3600)/(Mf*CV);
27 printf('Em= %3.2f Percent',Em*100);
28 printf('\n');
29 printf('Eith= %3.2f Percent',Eith*100);
30 printf('\n');
```

Scilab code Exa 7.21.1 Example 21

```
1 clc
2 clear
3
4 W=50;
5 S=7;
6 D=1.25;
7 N=450;
```

```
Mf=4;
CV=43000;
Em=0.7;
Reff=9.81*(D/2);

BP=[2*(22/7)*N*(W-S)*Reff]/(60*1000);
Ebth=(BP*3600)/(Mf*CV);
printf('Ebth= %3.2f Percent',Ebth*100);
printf('\n');

Eith=Ebth/Em;
printf('Eith= %3.2f Percent',Eith*100);
printf('\n');
```

Scilab code Exa 7.22.1 Example 22

```
clc
clear

T=640;
D=0.21;
N=350;
L=0.28;
Pm=5.6;
Mf=8.16;
CV=42705;

BP=[2*(22/7)*N*T]/60000;
printf('Brake Power= %3.2f kW',BP/1000);
printf('\n');

A=(22/7)*(1/4)*D*D;
IP=(Pm*100*A*L*N)/60;

Em=BP/IP;
```

```
printf('Em= %3.2f Percent',Em*100);
printf('\n');

Eith=(IP*3600)/(Mf*CV);
printf('Eith= %3.2f Percent',Eith*100);
printf('\n');

Ebth=(BP*3600)/(Mf*CV);
printf('Ebth= %3.2f Percent',Ebth*100);
printf('\n');

BSFC=Mf/BP;
printf('BSFC= %3.2f kg/kWh',BSFC);
printf('\n');
```

Scilab code Exa 7.23.1 Example 23

```
clc
clear

IP=37;
FP=6;
BSFC=0.28;
CV=44300;

BP=IP-FP;
Em=(IP-FP)/IP;
printf('Em= %3.2f Percent',Em*100);
printf('\n');

Mf=BSFC*BP;
Ebth=(BP*3600)/(Mf*CV);
printf('Ebth= %3.2f Percent',Ebth*100);
printf('\n');

```

```
19 Eith=Ebth/Em;
20 printf('Eith= %3.2f Percent',Eith*100);
21 printf('\n');
```

Scilab code Exa 7.24.1 Example 24

```
1  clc
2  clear
3
4  D=0.1;
5  L=0.125;
6  Pm=2.6;
7  W=60;
8  S=19;
9  Reff=0.4;
10 r=6;
11 Mf=1;
12 CV=42000;
13 N=2000;
14
15 A=(22/7)*(1/4)*D*D;
16
17 IP=(Pm*100*A*L*N)/(60*2);
18 printf('indicated Power= %3.2f kW',IP);
19 printf('\n');
20
21 BP=(2*(22/7)*N*(W-S)*Reff)/60000;
22 printf('Brake Power= %3.2f kW',BP);
23 printf('\n');
24
25 Em=BP/IP;
26 printf('Em= %3.2f Percent',Em*100);
27 printf('\n');
28
29 Ebth=(BP*3600)/(Mf*CV);
```

```
30 printf('Ebth= %3.2f Percent',Ebth*100);
31 printf('\n');
32
33 Eith=Ebth/Em;
34 printf('Eith= %3.2f Percent',Eith*100);
35 printf('\n');
36
37 G=1.4;
38 Ea=1-[1/(r^(G-1))];
39 printf('Ea= %3.2f Percent',Ea*100);
40 printf('\n');
41
42 Er=Ebth/Ea;
43 printf('Er= %3.2f Percent',Er*100);
44 printf('\n');
```

Scilab code Exa 7.25.1 Example 25

```
1 clc
2 clear
3
4 IP=30;
5 N=2500;
6 Pm=800;
7 Em=0.8;
8 LD=1.5;
9 Ebth=0.28;
10 CV=44000;
11
12 BP=IP*Em;
13 printf('Brake Power= %3.2f kW',BP);
14 printf('\n');
15
16 Mf=(BP/(Ebth*CV));
17 printf('Mass Flow Rate= %3.2f kg/hr',Mf*3600);
```

```
18 printf('\n');
```

Chapter 8

Air Compressors

Scilab code Exa 8.1.1 Example 1

```
1  clc
2  clear
3
4  P1=100;
5  T1=300;
6  P2=650;
7  n=1.25;
8  r=0.05;
9
10 Ev=1-[r*(((P2/P1)^(1/n))-1)];
11 printf('Volumetric Efficiency= %2.2f Percent',Ev
       *100);
12 printf('\n');
```

Scilab code Exa 8.2.1 Example 2

```
1  clc
2  clear
```

```
3
4 D=0.24;
5 LN=5/6;
6 P1=100;
7 P2=1000;
8 n=1.35;
9
10 A=(22/7)*(1/4)*D*D;
11
12 IP=[n/(n-1)]*[P1*A*LN]*[((P2/P1)^((n-1)/n))-1];
13 printf('Indicated Power= %2.2f kW',IP);
14 printf('\n');
```

Scilab code Exa 8.3.1 Example 3

```
1 clc
2 clear
3
4 N=300;
5 D=0.2;
6 L=0.24;
7 P1=1.01325;
8 P2=8*1.01325;
9 n=1.35;
10 Et=0.96;
11 Em=0.85;
12 Vs=(22/7)*(1/4)*D*D*L;
13
14 IP=[n/(n-1)]*[P1*Vs]*[N/60]*[((P2/P1)^((n-1)/n))-1];
15 printf('Indicated Power= %2.1f kW',IP*100);
16 printf('\n');
17
18 BP=IP/(Et*Em);
19 printf('Brake Power= %2.1f kW',BP*100);
20 printf('\n');
```

Scilab code Exa 8.4.1 Example 4

```
clc
clear

n=1.35;
P1=1.013;
V1=1/60;
P2=7;
Et=0.85;
Em=0.9;

IP=[n/(n-1)]*[P1*100*V1]*[((P2/P1)^((n-1)/n))-1];
printf('Indicated Power= %2.1f kW',IP);
printf('\n');

BP=IP/(Et*Em);
printf('Brake Power= %2.1f kW',BP);
printf('\n');
```

Scilab code Exa 8.5.1 Example 5

```
clc
clear

n=1.2;
P1=1;
P2=6;
Vs=1.5/60;

IP=[n/(n-1)]*[P1*100*Vs]*[((P2/P1)^((n-1)/n))-1];
```

```
10 printf('Indicated Power= %2.1f kW',IP);
11 printf('\n');
12 MP=6.55;
13 Em=IP/MP;
14 printf('Mechanical Efficiency= %2.1f Percent',Em
      *100);
15 printf('\n');
```

Scilab code Exa 8.6.1 Example 6

```
1  clc
2  clear
3
4  N=300;
5  V14=14/(2*N);
6  Vs=0.023/(1.05-0.22);
7  n=1.3;
8  P1=1.013;
9  P2=7;
10 IP=[n/(n-1)]*[P1*100*V14]*[((P2/P1)^((n-1)/n))
      -1]*[2*N/60];
11 printf('Indicated Power= %2.1f kW',IP);
12 printf('\n');
13
14 T1=288;
15 T2=T1*[(P2/P1)^((n-1)/n)];
16 printf('Delivery Temperature= %2.0f K',T2);
17 printf('\n');
18
19 printf('Swept Volume= %2.4f m^3',Vs);
20 printf('\n');
```

Scilab code Exa 8.7.1 Example 7

```
clc
clear

P1=1;
P2=10;
Vs=0.015;
FAD=3;
Vc=Vs*0.06;
n=1.3;
T1=20+273;

IP=[n/(n-1)]*[P1*100*3]*[((P2/P1)^((n-1)/n))-1];
printf('Indicated Power= %2.1f kW',IP/60);
printf('\n');

V4=Vc*[(P2/P1)^(1/n)];
V1=Vs+Vc;
V14=0.0107;
RS=3/V14;
printf('Rotation Speed= %2.0f RPM',RS);
printf('\n');
Tf=288;
Pf=101.325;
Vf=[P1*100*(FAD)*Tf]/[T1*Pf];
printf('Vf= %2.4f m^3/min',Vf);
printf('\n');

Mcd=V1/(V14);
printf('Mcd= %2.1f  ',Mcd);
printf('\n');
```

Scilab code Exa 8.8.1 Example 8

```
clc
clear
```

```
3
4 P1=1;
5 P2=10;
6 Vs=0.014;
7 n=1.3;
8 V1=3;
9 FAD=3;
10
11 W=[n/(n-1)]*[P1*100*V1/60]*[((P2/P1)^((n-1)/n))-1];
12 printf('Power required= %2.1f kW',W);
13 printf('\n');
14
15 RPM=FAD/Vs;
16 printf('Rotational Speed= %2.0f rpm',RPM);
17 printf('\n');
```

Scilab code Exa 8.9.1 Example 9

```
1 clc
2 clear
3
4 Vs=5.665/600;
5 Vc=0.04*Vs;
6 V3=Vc;
7 n=1.3;
8 P3=5.6;
9 P2=0.97;
10 V4=V3*[(P3/P2)^(1/n)];
11 V1=Vs+Vc;
12 Vd=V1-V4;
13 T1=300;
14 Tf=288;
15 P1=0.96;
16 Pf=1.01325;
17 Vf=[Tf*P1*Vd]/[Pf*T1];
```

```
18 Mcd=V1/(Vd);
19 printf('Vf= %2.4f m^3/cycle',Vf);
20 printf('\n');
21 printf('Mc/Md= %2.2f ',Mcd);
22 printf('\n');
23
24 N=600;
25 W=[n/(n-1)]*[P1*100*Vd]*[((P3/P1)^((n-1)/n))-1];
26 IP=W*N/60;
27 printf('Indicated Power= %2.2f kW',IP);
28 printf('\n');
```

Scilab code Exa 8.10.1 Example 10

```
1 clc
2 clear
3
4 IP=15;
5 n=1.2;
6 P1=100;
7 P2=700;
8 x=[(P2/P1)^((n-1)/n)]-1;
9 V1N=[IP*(n-1)*60]/[n*P1*x*2];
10 LN=150/2;
11 D2=V1N*4/[(22/7)*LN];
12 D=D2^0.5;
13 L=D*1.5;
14 printf('D= %2.0f mm',D*1000);
15 printf('\n');
16 printf('L= %2.0f mm',L*1000);
17 printf('\n');
```

Scilab code Exa 8.11.1 Example 11

```
clc
clear

P1=1;
P2=16;
n=1.3;
LN=100;
N=350;
IP=30;
Ev=0.95;

L=LN/N;
x=[((P2/P1)^((n-1)/n))-1];
V14=[IP*(n-1)*60]/[n*P1*100*x*N];
Vs=V14/Ev;
D2=Vs*4/[(22/7)*L];
D=D2^0.5;
printf('D= %2.0f mm',D*1000);
printf('\n');
printf('L= %2.0f mm',L*1000);
printf('\n');
```

Scilab code Exa 8.12.1 Example 12

```
clc
clear

D=0.2;
L=0.3;
Vs=(22/7)*(1/4)*D*D*L;
Vc=0.04*Vs;

V3=Vc;
P2=9;
P1=1;
```

```
n=1.3;
V4=V3*[(P2/P1)^(1/n)];
V1=Vs+Vc;
W=[n/(n-1)]*[P1*100]*[V1-V4]*[((P2/P1)^((n-1)/n))
   -1];
R=0.287;
T1=15+273;
Md=[P1*(V1-V4)*100]/[R*T1];
Wpkg=W/Md;
printf('Word done per kg: %3.2f kJ/kg of air',Wpkg);
printf('\n');

T2=T1*[(P2/P1)^((n-1)/n)];
G=1.4;
Q=[(G-n)/(G-1)]*[(R*(T1-T2))/(n-1)];
printf('Heat Transfereed: %3.2f kJ/kg',Q);
printf('\n');

Pm=W/Vs;
printf('Mean Effective Pressure: %3.2f kPa',Pm);
printf('\n');

Mac=V1/(V1-V4);
printf('Mass of air compressed to delivered: %3.2f '
   ,Mac);
printf('\n');

Tf=T1;
Pf=101.325;
Vf=[P1*100*(V1-V4)*Tf]/[Pf*T1];
RPM=500;
Vf=Vf*RPM;
printf('FAD at standard condition: %3.2f m^3/min',Vf
   );
printf('\n');

IP=[W*RPM]/60;
Etrans=0.92;
```

```
47 Emech=0.85;
48 Emotor=0.75;
49 MP=IP/[Etrans*Emech*Emotor];
50 printf('Motor Power: %3.2f kW',MP);
51 printf('\n');
52
53 MAC=Md*RPM;
54 printf('Mass of air compressed: %3.2f kg/min',MAC);
55 printf('\n');
56
57 ACC=MAC*Mac;
58 printf('Air compressed in cylinder: %3.2f kg/min',
      ACC);
59 printf('\n');
60
61 printf('End Temperature: %3.2f K',T2);
62 printf('\n');
```

Scilab code Exa 8.13.1 Example 13

```
1  clc
2  clear
3
4  Vs=0.015;
5  Vc=0.06*Vs;
6  V3=Vc;
7  n=1.3;
8  P2=10;
9  P1=1;
10 N=280;
11
12 V4=V3*[(P2/P1)^(1/n)];
13 printf('V4: %3.4f m^3/cycle',V4);
14 printf('\n');
15 printf('V3: %3.4f m^3/cycle',V3);
```

```
16 printf('\n');
17
18 V1=Vs+Vc;
19 printf('V1: %3.4f m^3/cycle',V1);
20 printf('\n');
21
22 V14=V1-V4;        //Suction Volume
23 V2=V1*[(P1/P2)^(1/n)];
24 IP=[n/(n-1)]*[P1*100*(V14)]*[((P2/P1)^((n-1)/n))
      -1]*[N/60];
25 printf('IP: %3.0f kW',IP);
26 printf('\n');
```

Scilab code Exa 8.14.1 Example 14

```
1  clc
2  clear
3
4  P2=6;
5  P1=0.96;
6  n=1.3;
7  CV=0.04;
8
9  Ev=[1-[CV*[((P2/P1)^(1/n))-1]]]*100;
10 printf('Clearance Volumetric Efficiency: %3.1f
      Percent',Ev);
11 printf('\n');
12
13 D=0.09;
14 L=0.1;
15 Vs=(22/7)*(1/4)*(D*D*L);
16 Vc=0.04*Vs;
17 V4=Vc*[(P2/P1)^(1/n)];
18 V1=Vc+Vs;
19 EDV=V1-V4;
```

```
20 printf('Effective Displacement Volume: %3.5f m^3',
      EDV);
21 printf('\n');
22
23 T1=313;
24 Tf=293;
25 Pf=1;
26 Vf=[(P1*(EDV)*Tf)]/[T1*Pf];
27 N=410;
28 FAD=Vf*N*2*60;
29 printf('Free air delivered: %3.2f m^3',FAD);
30 printf('\n');
31
32 W=[n/(n-1)]*[P1*100*(V1-V4)]*[((P2/P1)^((n-1)/n))
      -1];
33 IP=W*2*N/60;
34 printf('Indicated Power: %3.2f kW',IP);
35 printf('\n');
```

Scilab code Exa 8.15.1 Example 15

```
1 clc
2 clear
3
4 P1=1;
5 P2=5;
6 T1=27+273;
7 m=1;
8 R=0.287;
9
10 W1=m*R*T1*(log(P2/P1));
11 printf('Work in isothermal process: %3.1f kJ',W1);
12 printf('\n');
13
14 G=1.4;
```

```
15 W2=[G/(G-1)]*[m*R*T1]*[((P2/P1)^((G-1)/G))-1];
16 printf('Work in isentropic process: %3.0f kJ',W2);
17 printf('\n');
18
19 n=1.25;
20 W3=[n/(n-1)]*[m*R*T1]*[((P2/P1)^((n-1)/n))-1];
21 printf('Work in polytropic process: %3.1f kJ',W3);
22 printf('\n');
```

Scilab code Exa 8.16.1 Example 16

```
1  clc
2  clear
3
4  IP=41;
5  P1=1;
6  T1=17+273;
7  P2=7;
8  N=100;
9  n=1.2;
10
11 L=150/[2*N];
12 V1=(22/7)*(1/4)*(L);          //Along with D^2
13 W=[n/(n-1)]*[P1*100*V1]*[((P2/P1)^((n-1)/n))-1];
14 D2=[IP*60]/[W*2*N];
15 D=sqrt(D2);
16 printf('D: %3.3f m',D);
17 printf('\n');
```

Scilab code Exa 8.17.1 Example 17

```
1  clc
2  clear
```

```
3
4 D=0.15;
5 L=0.2;
6 P1=1;
7 T1=17+273;
8 P2=7;
9 N=100;
10 R=0.287;
11 V1=(22/7)*(1/4)*D*D*L;
12 m=[P1*100*V1]/[R*T1];
13 Mpm=m*N;
14 n=1.25;
15
16 IP=[n/(n-1)]*[P1*100*V1]*[((P2/P1)^((n-1)/n))-1]*[N
     /60];
17 printf('Mass/min: %3.1f Mpm',Mpm);
18 printf('\n');
19
20 printf('Indicated Power: %3.1f kW',IP);
21 printf('\n');
22
23 T2=T1*[(P2/P1)^((n-1)/n)];
24 printf('T2: %3.1f K',T2);
25 printf('\n');
```

Scilab code Exa 8.18.1 Example 18

```
1 clc
2 clear
3
4 D=0.15;
5 N=100;
6 L=0.2;
7 P1=1;
8 T1=27+273;
```

```
P2=6;
n=1.25;

Vs=(22/7)*(1/4)*D*D*L;
Vc=0.05*Vs;
V1=Vs+Vc;
V4=Vc*[(P2/P1)^(1/n)];

IP=[n/(n-1)]*[P1*100*(V1-V4)]*[((P2/P1)^((n-1)/n))
   -1];
IPf=IP**(N/60)
printf('IP: %3.2f kJ',IPf);
printf('\n');

Pm=IP/Vs;
printf('Mean Effective Pressure: %3.2f kN/m^2',Pm);
printf('\n');
```

Scilab code Exa 8.19.1 Example 19

```
clc
clear

n=1.2;
m=5;
R=0.287;
T2=107+273;
T1=27+273;
IP=[n/(n-1)]*[m/60]*[R*(T2-T1)];
printf('Air Power: %3.2f kW',IP);
printf('\n');

BP=14;
Em=IP*100/BP;
printf('Mechanical Efficiency: %3.0f Percent',Em);
```

```
16 printf('\n');
```

Scilab code Exa 8.20.1 Example 20

```
1  clc
2  clear
3
4  V1=50;
5  P1=1;
6  P2=5.5;
7  n=1.3;
8  Em=0.82;
9
10 IP=[n/(n-1)]*[P1*100*V1]*[((P2/P1)^((n-1)/n))
      -1]*[1/60];
11 BP=IP/Em;
12
13 printf('IP: %3.1f kW',IP);
14 printf('\n');
15 printf('BP: %3.1f kW',BP);
16 printf('\n');
17
18 IsoP=P1*100*V1*[log(P2/P1)]*(100/60);
19 Eo=IsoP/BP;
20 printf('Isothermal Efficiecy: %3.1f Percent',Eo);
21 printf('\n');
```

Scilab code Exa 8.21.1 Example 21

```
1  clc
2  clear
3
4  P1=1;
```

```
5  P2=5.5;
6  T1=27+273;
7  Pa=1.01325;
8  Ta=17+273;
9  C=0.06;
10 n=1.3;
11
12 Ev=[(P1*Ta)/(Pa*T1)]*[1+C-(C*((P2/P1)^(1/n)))];
13 printf('Volumetric Efficiency: %3.0f Percent',Ev
       *100);
14 printf('\n');
```

Scilab code Exa 8.22.1 Example 22

```
1  clc
2  clear
3
4  V14=7.5;
5  P1=1;
6  T1=27+273;
7  P2=5.5;
8  n=1.3;
9  C=0.06;
10
11 T2=T1*[(P2/P1)^((n-1)/n)];
12 printf('T2: %3.1f K',T2);
13 printf('\n');
14
15 Ev=1+C-[C*((P2/P1)^((1/n)))];
16 printf('Vol Eff: %3.1f Percent',Ev*100);
17 printf('\n');
18
19 AP=[n/(n-1)]*[P1*100*V14/60]*[((P2/P1)^((n-1)/n))
       -1];
20 printf('Air Power: %3.1f kW',AP);
```

```
21 printf('\n');
22
23 Em=0.9;
24 BP=AP/Em;
25 printf('BP: %3.1f kW',BP);
26 printf('\n');
27
28 Emot=0.96;
29 EMC=BP/Emot;
30 printf('Electric Motor Capacity: %3.1f kW',EMC);
31 printf('\n');
```

Scilab code Exa 8.23.1 Example 23

```
1  clc
2  clear
3
4  V1=5;
5  P1=1;
6  P2=5;
7  n=1.25;
8  Em=0.9;
9  IP=[n/(n-1)]*[P1*100*V1/60]*[((P2/P1)^((n-1)/n))-1];
10 SP=IP/Em;
11 printf('Shaft Power: %3.1f kW',SP);
12 printf('\n');
13
14 IsoP=P1*100*V1*(log(P2/P1))*(1/60);
15 Eo=IsoP/SP;
16 printf('Overall Efficiency: %3.0f Percent',Eo*100);
17 printf('\n');
```

Scilab code Exa 8.24.1 Example 24

```
clc
clear

V1=25;
P1=1;
P2=7;
N=460;
Em=0.8;
Ev=0.76;
Ei=0.81;

IsoP=P1*100*V1*(log(P2/P1));
IndP=IsoP/Ei;
Vs=V1/Ev;
Pm=IndP/Vs;
BP=IndP/(3600*Em);

printf('Mean Effective Pressure: %3.2f bar',Pm/100);
printf('\n');

printf('BP: %3.2f kW',BP);
printf('\n');
```

Scilab code Exa 8.25.1 Example 25

```
clc
clear

Va=3;
Pa=1;
Ta=17+273;
P2=8.2;
N=300;
n=1.35
LD=1.2;
```

```
Em=0.9;
C=0.05;

P1=Pa-0.05;
T1=Ta+10;
V14=[Pa*Va*T1]/[P1*Ta];

IP=[n/(n-1)]*[P1*100*V14/60]*[((P2/P1)^((n-1)/n))
   -1];
BP=IP/Em;
printf('BP: %3.1f kW',BP);
printf('\n');

Ev=1+C-[C*((P2/P1)^(1/n))];
printf('Volumetric Efficiency: %3.1f Percent',Ev
   *100);
printf('\n');

Vs=(22/7)*(1/4)*LD;
VsMin=Vs*2*N;
D3=V14/[VsMin*Ev];
D=D3^(1/3);
printf('Cylinder Diameter: %3.0f mm',D*1000);
printf('\n');
```

Scilab code Exa 8.26.1 Example 26

```
clc
clear

V1=1;
P1=1.013;
T1=15+273;
P2=7;
R=0.287;
```

```
n=1.35;

m=[P1*100*V1]/[R*T1];
printf('Mass of air per minute: %3.1f kg',m);
printf('\n');

T2=T1*[((P2/P1)^((n-1)/n))];
printf('T2: %3.1f K',T2);
printf('\n');

IP=[n/(n-1)]*[P1*100*V1/60]*[((P2/P1)^((n-1)/n))-1];
printf('IP: %3.1f kW',IP);
printf('\n');

IsoP=P1*100*V1*(1/60)*log(P2/P1);
Ei=IsoP/IP;
printf('Isothermal Efficiency: %3.0f Percent',Ei
   *100);
printf('\n');
```

Scilab code Exa 8.27.1 Example 27

```
clc
clear

P1=1.013;
T1=15+273;
P2=7;
FAD=0.3;
G=1.4;

IP=[G/(G-1)]*[P1*100*FAD/60]*[((P2/P1)^((G-1)/G))
   -1];
printf('For Isentropic process \n');
printf('IP: %3.1f kW',IP);
```

```
13 printf('\n');
14
15 T2=T1*[(P2/P1)^((G-1)/G)];
16 printf('T2: %3.0f K',T2);
17 printf('\n');
18
19 printf('For Reversible Isothermal process \n');
20 IP=P1*100*FAD*(1/60)*[log(P2/P1)];
21 printf('IP: %3.3f kW',IP);
22 printf('\n');
23
24 T2=T1;
25 printf('T2: %3.0f K',T2);
26 printf('\n');
27
28 printf('For Polytropic process \n');
29 n=1.25
30 IP=[n/(n-1)]*[P1*100*FAD/60]*[((P2/P1)^((n-1)/n))
      -1];
31 printf('IP: %3.3f kW',IP);
32 printf('\n');
33
34 T2=T1*[(P2/P1)^((n-1)/n)];
35 printf('T2: %3.2f K',T2);
36 printf('\n');
```

Scilab code Exa 8.28.1 Example 28

```
1 clc
2 clear
3
4 V1=94;
5 P1=1;
6 T1=25+273;
7 P2=9;
```

```
8
9  printf('For isothermal process \n');
10 T2=T1;
11 printf('T2: %3.0f K',T2);
12 printf('\n');
13
14 P=P1*100*V1*log(P2/P1);
15 printf('Power required: %3.0f kW',P/60);
16 printf('\n');
17
18 Q=P;
19 printf('Heat Rejected: %3.0f KW',Q/60);
20 printf('\n');
21
22 printf('\n For adiabatic process \n');
23 G=1.4;
24 T2=T1*[(P2/P1)^((G-1)/G)];
25 printf('T2: %3.0f K',T2);
26 printf('\n');
27
28 P=[G/(G-1)]*[P1*100*V1/60]*[((P2/P1)^((G-1)/G))-1];
29 printf('Power required: %3.0f kW',P);
30 printf('\n');
31
32 Q=0;
33 printf('Heat Rejected: %3.0f kW',Q);
34 printf('\n');
35
36 printf('\n For adiabatic process \n');
37 n=1.25;
38 T2=T1*[(P2/P1)^((n-1)/n)];
39 printf('T2: %3.0f K',T2);
40 printf('\n');
41
42 P=[n/(n-1)]*[P1*100*V1/60]*[((P2/P1)^((n-1)/n))-1];
43 printf('Power required: %3.0f kW',P);
44 printf('\n');
45
```

```
46 R=0.287;
47 Cp=1.005;
48
49 m=[P1*100*V1]/[R*T1];
50 H=m*(1/60)*Cp*(T2-T1);
51 Q=H-P;
52 printf('Heat Rejected: %3.0f kW',Q);
53 printf('\n');
```

Scilab code Exa 8.29.1 Example 29

```
1  clc
2  clear
3
4  P1=1;
5  P2=12;
6  n=1.3;
7  N=350;
8  L=180/(2*N);
9  IP=30;
10 Ev=0.92;
11
12 W=[n/(n-1)]*[P1*100]*[((P2/P1)^((n-1)/n))-1];    //
       with (V1-V4)
13 V14=[IP*60]/[N*W];
14 Vs=V14/Ev;
15 D2=Vs*4/[(22/7)*L];
16 D=sqrt(D2);
17 printf('D: %3.3f m',D);
18 printf('\n');
19 printf('L: %3.3f m',L);
20 printf('\n');
```

Scilab code Exa 8.30.1 Example 30

```
clc
clear

m=1;
P1=1;
P2=5;
T1=27+273;
n=1.25;
R=0.287;

W=m*R*T1*log(P2/P1);
printf('Work Done for Isothermal Process: %3.2f kJ/
   kg \n\n',W);
printf('\n');

G=1.4;
W=[G/(G-1)]*[m*R*T1]*[((P2/P1)^((G-1)/G))-1];
printf('Work Done for Isentropic Process: %3.2f kJ/
   kg \n\n',W);
printf('\n');

W=[n/(n-1)]*[m*R*T1]*[((P2/P1)^((n-1)/n))-1];
printf('Work Done for Polytropic Process: %3.2f kJ/
   kg \n\n',W);
printf('\n');
```

Scilab code Exa 8.31.1 Example 31

```
clc
clear

D=0.15;
L=0.3;
```

```
P1=1;
T1=27+273;
P2=8;
N=120;
G=1.4;
R=0.287;
Vs=(22/7)*(1/4)*D*D*L;

m=[P1*100*Vs]/[R*T1];
printf('Mass of air compressed per cycle: %3.4f kJ/
    cycle ',m);
printf('\n');

W=[G/(G-1)]*[P1*100*Vs]*[((P2/P1)^((G-1)/G))-1];
printf('Work required per cycle: %3.3f kJ/cycle ',W)
    ;
printf('\n');

P=(W*N)/60;
printf('Power required to drive compressor: %3.2f kJ
    /cycle ',P);
printf('\n');
```

Chapter 9

Pumps

Scilab code Exa 9.1.1 Example 1

```
1  clc
2  clear
3
4  D=0.3;
5  L=0.6;
6  N=60;
7  Hs=5;
8  Hd=10;
9  Ep=0.8;
10 Qa=0.075;
11
12 A=(22/7)*(1/4)*D*D;
13 Rho=1000;
14 g=9.81;
15
16 F1=Rho*g*Hs*A;
17 F2=Rho*g*Hd*A;
18
19 TF=F1+F2;
20 printf('Total Force Required: %2.2f kN',TF/1000);
21 printf('\n');
```

```
22
23 Q=(2*L*A*N)/60;
24 Qa=0.075;
25 Slip=(Q-Qa)/Q;
26 printf('Percentage Slip: %2.2f Percent',Slip*100);
27 printf('\n');
28
29 Cd=Qa/Q;
30
31 P=(Rho*g*Qa*(Hs+Hd))/Ep;
32 printf('Power input: %2.2f kW',P/1000);
33 printf('\n');
```

Scilab code Exa 9.2.1 Example 2

```
1 clc
2 clear
3
4 Qa=0.025;
5 Hm=20;
6 L=0.4;
7 D=0.3;
8
9 A=(22/7)*(1/4)*D*D;
10 Slip=0.02;
11 Q=25/[1000*(1-Slip)];
12
13 N=(Q*60)/(L*A);
14
15 printf('Speed of Pump: %2.2f RPM',N);
16 printf('\n');
```

Scilab code Exa 9.3.1 Example 3

```
clc
clear

Hs=32;
N=1450;
Eff=0.85;
Q=0.05;
Hfs=1;
Hfd=6;
Hm=Hs+Hfd+Hfs;
Rho=1000;
g=9.81;

P=[Rho*g*Q*Hm]/Eff;
printf('Power Consumed: %2.2f kW',P/1000);
printf('\n');
```

Scilab code Exa 9.4.1 Example 4

```
clc
clear

Pm=25;
Em=0.9;
Q=0.063;
Hs=4;
Hd=25;
Rho=1000;
Hm=Hs+Hd;
g=9.81;

Ph=Rho*g*Q*Hm/1000;
Ps=Em*Pm;
Ep=Ph/Ps;

```

```
17 printf('Efficiency of Pump: %2.2f Percent',Ep*100);
18 printf('\n');
```

Chapter 13

Transmission of Motion and Power

Scilab code Exa 13.1.1 Example 1

```
1  clc
2  clear
3
4  N1=250;
5  D1=53;
6  D2=32;
7
8  N2=N1*(D1/D2);
9  printf('Speed of shaft: %2.2f RPM',N2);
10 printf('\n');
```

Scilab code Exa 13.2.1 Example 2

```
1  clc
2  clear
3
```

```
4  D1=600;
5  D2=300;
6  N1=100;
7  VR=D1/D2;
8  N2=VR*N1;
9
10 printf('Case One \n');
11 printf('Velocity Ratio= %2.2f',VR);
12 printf('\n');
13 printf('Speed of driven shaft= %2.2f RPM',N2);
14 printf('\n\n');
15
16 printf('Case Two \n');
17 VR=(D1+5)/(D2+5);
18 N2=VR*N1;
19 printf('Velocity Ratio= %2.2f',VR);
20 printf('\n');
21 printf('Speed of driven shaft= %2.2f RPM',N2);
22 printf('\n\n');
23
24 printf('Case Three \n');
25 S=4;
26 VR=[(D1+5)/(D2+5)]*[(100-S)/100];
27 N2=VR*N1;
28 printf('Velocity Ratio= %2.2f',VR);
29 printf('\n');
30 printf('Speed of driven shaft= %2.2f RPM',N2);
31 printf('\n\n');
```

Scilab code Exa 13.3.1 Example 3

```
1  clc
2  clear
3
4  D1=0.3;
```

```
D2=0.2;
C=3;

L1=[(22/7)*(1/2)*(D1+D2)]+[((D1+D2)^2)/(4*C)]+(2*C);
L2=[(22/7)*(1/2)*(D1+D2)]+[((D1-D2)^2)/(4*C)]+(2*C);

L=L2-L1;
printf('The belt length is to be reduced by %2.4f mm
    ',(0-L)*1000);
printf('\n');
```

Scilab code Exa 13.4.1 Example 4

```
clc
clear

D=1;
P=5000;
N=250;
Mew=0.25;
PP=20;
Theta=170*(22/7)*(1/180);
V=((22/7)*D*N)/60;

T12=exp(Mew*Theta)-1;
T2=(P/(V*T12));
T1=(T12+1)*T2;
W=T1/PP;

printf('Width of belt= %2.2f mm',W);
printf('\n');
```

Scilab code Exa 13.5.1 Example 5

```
clc
clear

N1=1000;
Z1=30;
Z2=45;
Z3=75;

N13=Z3/Z1;
N3=N1/N13;

printf('Velocity Ratio of gear train= %2.1f ',N13);
printf('\n');
printf('N3= %2.1f RPM',N3);
printf('\n');
```

Scilab code Exa 13.6.1 Example 6

```
clc
clear

Na=600;
Za=25;
Zb=50;
Zc=20;
Zd=40;
Nad=(Zb/Za)*(Zd/Zc);
Nd=Na/Nad;

printf('Speed of Output Shaft= %2.1f RPM',Nd);
printf('\n');
```