

Scilab Textbook Companion for
Elements of Mechanical Engineering
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Book Description

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

Contents

List of Scilab Codes	4
1 Introduction	10
3 Properties of Gases	14
4 Properties of Steam	56
5 Steam Boilers	95
6 Heat Engines	111
7 Internal Combustion Engines	139
8 Air Compressors	158
9 Pumps	184
13 Transmission of Motion and Power	188

List of Scilab Codes

Exa 1.1.1	Example1	10
Exa 1.1.2	Example2	10
Exa 1.1.3	Example3	11
Exa 1.1.4	Example4	11
Exa 1.1.5	Example5	11
Exa 1.1.6	Example6	12
Exa 1.1.7	Example7	12
Exa 1.1.8	Example8	13
Exa 3.1.1	Example1	14
Exa 3.2.1	Example2	15
Exa 3.3.1	Example3	16
Exa 3.4.1	Example4	16
Exa 3.5.1	Example5	17
Exa 3.6.1	Example6	18
Exa 3.7.1	Example7	19
Exa 3.8.1	Example8	20
Exa 3.9.1	Example9	21
Exa 3.13.1	Example13	22
Exa 3.14.1	Example14	23
Exa 3.15.1	Example15	24
Exa 3.16.1	Example16	25
Exa 3.17.1	Example17	26
Exa 3.18.1	Example18	27
Exa 3.19.1	Example19	28
Exa 3.20.1	Example20	29
Exa 3.21.1	Example21	30
Exa 3.22.1	Example22	31
Exa 3.23.1	Example23	32

Exa 3.24.1 Example24	33
Exa 3.25.1 Example25	34
Exa 3.26.1 Example26	35
Exa 3.27.1 Example27	36
Exa 3.28.1 Example28	37
Exa 3.29.1 Example29	38
Exa 3.30.1 Example30	40
Exa 3.31.1 Example31	41
Exa 3.32.1 Example32	42
Exa 3.33.1 Example33	43
Exa 3.34.1 Example34	44
Exa 3.37.1 Example37	45
Exa 3.38.1 Example38	46
Exa 3.39.1 Example39	47
Exa 3.40.1 Example40	48
Exa 3.41.1 Example41	49
Exa 3.42.1 Example42	50
Exa 3.43.1 Example43	51
Exa 3.44.1 Example44	52
Exa 3.45.1 Example45	53
Exa 3.46.1 Example46	54
Exa 4.1.1 Example 1	56
Exa 4.2.1 Example 2	58
Exa 4.3.1 Example 3	59
Exa 4.4.1 Example 4	59
Exa 4.5.1 Example 5	60
Exa 4.6.1 Example 6	61
Exa 4.7.1 Example 7	62
Exa 4.8.1 Example 8	63
Exa 4.9.1 Example 9	64
Exa 4.10.1 Example 10	64
Exa 4.11.1 Example 11	65
Exa 4.12.1 Example 12	66
Exa 4.13.1 Example 13	67
Exa 4.14.1 Example 14	68
Exa 4.15.1 Example 15	69
Exa 4.16.1 Example 16	70
Exa 4.17.1 Example 17	71

Exa 4.18.1 Example 18	72
Exa 4.19.1 Example 19	72
Exa 4.20.1 Example 20	73
Exa 4.21.1 Example 21	74
Exa 4.22.1 Example 22	75
Exa 4.23.1 Example 23	77
Exa 4.24.1 Example 24	79
Exa 4.25.1 Example 25	80
Exa 4.26.1 Example 26	81
Exa 4.27.1 Example 27	82
Exa 4.28.1 Example 28	83
Exa 4.29.1 Example 29	83
Exa 4.30.1 Example 30	84
Exa 4.31.1 Example 31	85
Exa 4.32.1 Example 32	86
Exa 4.33.1 Example 33	87
Exa 4.34.1 Example 34	88
Exa 4.35.1 Example 35	88
Exa 4.36.1 Example 36	89
Exa 4.37.1 Example 37	90
Exa 4.38.1 Example 38	91
Exa 4.39.1 Example 39	92
Exa 4.40.1 Example 40	93
Exa 4.41.1 Example 41	93
Exa 5.1.1 Example 1	95
Exa 5.2.1 Example 2	96
Exa 5.3.1 Example 3	97
Exa 5.4.1 Example 4	97
Exa 5.5.1 Example 5	98
Exa 5.6.1 Example 6	99
Exa 5.7.1 Example 7	100
Exa 5.8.1 Example 8	101
Exa 5.9.1 Example 9	101
Exa 5.10.1 Example 10	102
Exa 5.11.1 Example 11	103
Exa 5.12.1 Example 12	104
Exa 5.13.1 Example 13	104
Exa 5.14.1 Example 14	105

Exa 5.15.1	Example 15	106
Exa 5.16.1	Example 16	107
Exa 5.17.1	Example 17	108
Exa 5.18.1	Example 18	109
Exa 5.19.1	Example 19	109
Exa 6.1.1	Example 1	111
Exa 6.2.1	Example 2	112
Exa 6.3.1	Example 3	113
Exa 6.4.1	Example 4	113
Exa 6.5.1	Example 5	114
Exa 6.6.1	Example 6	115
Exa 6.7.1	Example 7	115
Exa 6.8.1	Example 8	115
Exa 6.9.1	Example 9	116
Exa 6.10.1	Example 10	117
Exa 6.11.1	Example 11	118
Exa 6.12.1	Example 12	119
Exa 6.13.1	Example 13	119
Exa 6.14.1	Example 14	121
Exa 6.15.1	Example 15	122
Exa 6.16.1	Example 16	124
Exa 6.17.1	Example 17	125
Exa 6.18.1	Example 18	126
Exa 6.20.1	Example 20	127
Exa 6.21.1	Example 21	128
Exa 6.22.1	Example 22	129
Exa 6.23.1	Example 23	129
Exa 6.24.1	Example 24	130
Exa 6.25.1	Example 25	131
Exa 6.26.1	Example 26	132
Exa 6.27.1	Example 27	132
Exa 6.28.1	Example 28	133
Exa 6.29.1	Example 29	133
Exa 6.30.1	Example 30	134
Exa 6.31.1	Example 31	135
Exa 6.32.1	Example 32	136
Exa 6.33.1	Example 33	137
Exa 7.1.1	Example 1	139

Exa 7.2.1	Example 2	139
Exa 7.3.1	Example 3	140
Exa 7.4.1	Example 4	141
Exa 7.5.1	Example 5	141
Exa 7.6.1	Internal Combustion Engines	142
Exa 7.7.1	Example 7	142
Exa 7.8.1	Example 8	143
Exa 7.9.1	Example 9	144
Exa 7.10.1	Example 10	144
Exa 7.11.1	Example 11	145
Exa 7.12.1	Example 12	146
Exa 7.13.1	Example 13	146
Exa 7.14.1	Example 14	147
Exa 7.15.1	Example 15	147
Exa 7.16.1	Example 16	148
Exa 7.17.1	Example 17	149
Exa 7.18.1	Example 18	150
Exa 7.19.1	Example 19	151
Exa 7.20.1	Example 20	151
Exa 7.21.1	Example 21	152
Exa 7.22.1	Example 22	153
Exa 7.23.1	Example 23	154
Exa 7.24.1	Example 24	155
Exa 7.25.1	Example 25	156
Exa 8.1.1	Example 1	158
Exa 8.2.1	Example 2	158
Exa 8.3.1	Example 3	159
Exa 8.4.1	Example 4	160
Exa 8.5.1	Example 5	160
Exa 8.6.1	Example 6	161
Exa 8.7.1	Example 7	161
Exa 8.8.1	Example 8	162
Exa 8.9.1	Example 9	163
Exa 8.10.1	Example 10	164
Exa 8.11.1	Example 11	164
Exa 8.12.1	Example 12	165
Exa 8.13.1	Example 13	167
Exa 8.14.1	Example 14	168

Exa 8.15.1 Example 15	169
Exa 8.16.1 Example 16	170
Exa 8.17.1 Example 17	170
Exa 8.18.1 Example 18	171
Exa 8.19.1 Example 19	172
Exa 8.20.1 Example 20	173
Exa 8.21.1 Example 21	173
Exa 8.22.1 Example 22	174
Exa 8.23.1 Example 23	175
Exa 8.24.1 Example 24	175
Exa 8.25.1 Example 25	176
Exa 8.26.1 Example 26	177
Exa 8.27.1 Example 27	178
Exa 8.28.1 Example 28	179
Exa 8.29.1 Example 29	181
Exa 8.30.1 Example 30	182
Exa 8.31.1 Example 31	182
Exa 9.1.1 Example 1	184
Exa 9.2.1 Example 2	185
Exa 9.3.1 Example 3	185
Exa 9.4.1 Example 4	186
Exa 13.1.1 Example 1	188
Exa 13.2.1 Example 2	188
Exa 13.3.1 Example 3	189
Exa 13.4.1 Example 4	190
Exa 13.5.1 Example 5	190
Exa 13.6.1 Example 6	191

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;
```

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

Scilab code Exa 1.1.3 Example3

```
1 clc
2 clear
3
4 //Declaring values
5 Q=50;
6 W=40;
7 U=Q-W;
8 printf('Change in Internal Energy= %2.0f kJ',U);
```

Scilab code Exa 1.1.4 Example4

```
1 clc
2 clear
3
4 m=3000; //mass in kg
5 P=736; //Power in kW
6 t=5*3600; //Time in seconds
7 HV=27170 //Heating value in kJ/kg
8
9 E=P/((m/t)*HV);
10 Eff=E*100;
11 printf('Thermal Efficiency= %2.2f percent',Eff);
```

Scilab code Exa 1.1.5 Example5

```

1  clc
2  clear
3
4  U=22;           //Internal Energy in kJ/s
5  P2=0.95*1000;  //Pressure in kPa
6  V2=0.09;       //Volume in m^3/s;
7  P1=0.5*1000;
8  V1=0.15;
9  X=(P2*V2)-(P1*V1);
10 H=U+X;
11
12 printf('Change in Enthalpy: %2.1f kJ/s',H);

```

Scilab code Exa 1.1.6 Example6

```

1  clc
2  clear
3
4  Th=0.22;       //Thermal Efficiency
5  Hr=1260;       //Heat Rejected in MJ/hr
6  CV=42;         //Calorific Value of Coal
7  X=1-Th;
8  HI=Hr/X;       //Heat Input in MJ/hr
9
10 O=((HI-Hr)*1000)/3600; //Output
11 Mf=HI/CV;      //Mass of Fuel Used
12
13 printf('Power Output is %2.2f kW',O);
14 printf('\\n');
15 printf('Mass of Fuel used per hour: %2.1f kg/hr',Mf)
    ;

```

Scilab code Exa 1.1.7 Example7

```

1  clc
2  clear
3
4  m=2;           //mass in kg
5  T1=30+273;    //Temperature in K
6  T2=60+273;
7  Cp=4.187;
8  T=T2/T1;
9  X=double(log(T));
10 S=m*Cp*X;
11 printf('Entropy Change of Water: %1.4 f kJ/K',S);

```

Scilab code Exa 1.1.8 Example8

```

1  clc
2  clear
3
4  //Declaring Values
5  m=600;        //Mass in kg
6  z=50000;     //Distance in meters
7  V=2500000;   //Velocity in m/hr
8  g=7.9;       //Gravitational Field in m/s^2
9  Vel=V/3600;
10 KE=(0.5*m*Vel*Vel)/1000000; //Kinetic Energy in MJ
11 PE=(m*g*z)/1000000;        //Potential
    Energy in MJ
12
13 //Displaying Results
14 printf('The Kinetic Energy is %3.2 f MJ',KE);
15 printf('\\n')
16 printf('The Potential Energy is %3.2 f MJ',PE);

```

Chapter 3

Properties of Gases

Scilab code Exa 3.1.1 Example1

```
1  clc
2  clear
3
4  //Declaring Values
5  V=3;           //Volume in m^3
6  P1=2500;      //Pressure in kilobar
7  P2=1500;
8  T2=21+273;   //Temperature in Kelvin
9  T1=(T2*P1)/P2;
10 Cp=1.005;
11 Cv=0.718;
12 R=Cp-Cv;      //Universal Gas Constant
13 m=(P1*V)/(R*T1); //Calculating mass
14 H=m*Cp*(T2-T1);
15 U=m*Cv*(T2-T1);
16 Q=U;         //Since Constant Volume Process: Work
                Done=0
17 //Displaying Results
18 printf('Change in Enthalpy: %5.2f kJ',H);
19 printf('\n');
20 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: %2.3 f kJ ',W);
16 printf( '\n' );
17 Q=m*Cp*(T2-T1);
18 printf( 'The Heat Transfer: %2.3 f kJ ',Q);
19 printf( '\n' );
20 U=Q-W;
21 printf( 'The change in Internal Energy: %2.3 f 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: %2.3 f kJ',V1);
17 printf('\n');
18 V2=4*V1;
19 printf('The Final Volume: %2.3 f kJ',V2);
20 printf('\n');
21 x=V1/V2;
22 y=x^1.3;
23 P2=P1*y;
24 printf('The Final Pressure: %2.3 f bar',P2);
25 printf('\n');
26 x=V1/V2;
27 y=x^0.3;
28 T2=T1*y;
29 printf('The Final Temperature: %2.3 f 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: %3.2 f kJ/kg K', Cv);
27 printf( '\n' );
28 Cp=Cv+R;
29 printf( 'The Cp: %3.2 f 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: %3.2 f 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: %1.3 f 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: %1.2 f kJ',Q);
22 printf('\n')
23
24 V2=(T2*V1)/T1;
25 W=P1*100*(V2-V1);
26 printf('The Value of Work done: %1.2 f kJ',W);
27 printf('\n')
```

Scilab code Exa 3.23.1 Example23

```
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=28;
11 V1=3;
12 T1=100+273;
13 T2=37+273;
14 G=1.4;
15 Ro=8.314;
16
17 v=V1/m;
18 R=Ro/m;
19
20 P1=(m*R*T1)/V1;
21
22 printf('The Specific Volume: %1.3 f m^3/kg',v);
23 printf('\n')
24
25 printf('The Initial Pressure: %1.2 f kPa',P1);
26 printf('\n')
27
28 P2=(P1*T2)/T1;
29 printf('The Final Pressure: %1.2 f kPa',P2);
30 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

```

```

19 m=(P1*V1)/(R*T1);
20 T2=(P2*T1)/P1;
21
22 U=m*Cv*(T2-T1);
23 H=m*Cp*(T2-T1);
24
25 printf('Change in Internal Energy: %1.2f kJ',U);
26 printf('\n');
27
28 printf('Change in heat Energy: %1.2f kJ',H);
29 printf('\n')

```

Scilab code Exa 3.25.1 Example25

```

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 T1=27+273;
12 T2=197+273;
13 V1=2.1;
14 R=0.287;
15 Cp=1.005;
16
17 W=m*R*(T2-T1);
18 printf('Work Done: %1.2f kJ',W);
19 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: %1.2 f 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: %1.2 f 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: %1.2 f kJ/kg K',R);

```

```

20 printf( '\n' );
21
22 M=Ro/R;
23 printf( 'Molecular Mass: %1.2 f kg/kg mole ',M);
24 printf( '\n' );
25
26 G=(log(P1/P2))/(log(V2/V1));
27 printf( 'Ratio of Specific Heats: %1.2 f ',G);
28 printf( '\n' );
29
30 Cv=(R)/(G-1);
31 printf( 'Value of Cv: %1.2 f kJ/kg K',Cv);
32 printf( '\n' );
33
34 Cp=G*Cv;
35 printf( 'Value of Cp: %1.2 f 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: %1.2 f kJ',U);
41 printf( '\n' );
42
43 H=m*Cp*(T2-T1);
44 printf( 'Heat Transfer: %1.2 f kJ',H);
45 printf( '\n' );
46
47 W=((P1*100*V1)-(P2*100*V2))/(G-1);
48 printf( 'Work Done: %1.2 f 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: %1.2 f 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: %1.2 f
   bar ',P3);
25 printf('\n');
26 printf('Temperature after isothermal compression: %1
   .2 f K',T2);
27 printf('\n');
28
29 W1=((P1*100*V1)-(P2*100*V2))/(G-1);
30 printf('Work Developed during adiabatic expansion:
   %2.0 f kJ',W1);
31 printf('\n');
32
33 W2=(P2*100*V2)*log(V3/V2);
34 printf('Work of Compression: %1.2 f 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

```
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 P1=900;
12 T1=300+273;
13 T3=T1;
14 V2=3*V1;
15 R=0.287;
16 Cp=1.005;
17 G=1.4;
18 n=1.5;
19 Cv=0.718;
20
21 //Calculations
22 m=(P1*V1)/(R*T1);
23 T2=(V2*T1)/V1;
24 Q1=m*Cp*(T2-T1);
25 printf('Heat Received: %3.2f kJ',Q1);
26 printf('\n');
27
28 Q2=(m*Cv)*((n-G)/(n-1))*(T3-T2);
29 Q3=m*R*T3*(log(1/27));
30 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: %3.3 f
      kPa',P2);
24 printf('\n');
25 printf('The Temperature at end of Compression: %3.3 f
      K',T2);
26 printf('\n');
27 m=(P1*V1)/(R*T1);
28 printf('The Mass in the cylinder: %3.3 f kg',m);
29 printf('\n');
30 W=((P1*V1)-(P2*V2))/(n-1);
31 printf('The Work Done: %3.3 f kJ',W);
32 printf('\n');
33 Q=((G-n)/(G-1))*W;
34 printf('The Heat Transfer: %3.3 f 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: %3.4 f kg',m);
20 printf('\n');
21 n=(log(P2/P1))/(log(V1/V2));
22 printf('The value of n: %3.3 f ',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: %3.3 f 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: %2.2 f 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: %2.1 f K',T2);
21 printf( '\n' );
22 W=m*R*(T1-T2)/(n-1);
23 printf( 'Work done: %2.2 f 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

```
1  clc
2  clear
3
4  //Condition at 10 bar pressure
5  //Steam is wet
6
7  x=0.95;
8  P=10;          //in bars
9  Hf=762.8;      //in kJ/kg
10 Hfg=2015.3;    //in kJ/kg
11 H=Hf+(x*Hfg);
12 printf('Enthalpy : %3.2 f kJ/kg ',H);
13 printf('\n');
14
15 //Now we calculate Work Done
16 Vg=0.194;      //in m^3/kg
17 W=P*100*x*Vg;
18 U=H-W;
19 printf('Internal energy: %3.0 f kJ/kg ',U);
20 printf('\n');
```

Scilab code Exa 4.4.1 Example 4

```
1  clc
2  clear
3
4  //Condition at pressure 15 bars
5  P=15;          //in bars
6  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: %3.2 f kJ/kg',W);
13 printf('\n');
14 H=Hf+(x*Hfg);
15 U=H-W;
16 printf('Internal Energy: %3.1 f 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

```

```

6 Hf=604.7;           //in kJ/kg
7 Hfg=2133.8;        //in kJ/kg
8 Vg=0.463;          //in m^3/kg
9 x1=0.9;
10 H1=Hf+(x1*Hfg);
11 V1=x1*Vg;
12
13 //Now at 12 bar pressure
14 P2=12;             //in bars
15 V2=(P1*V1)/P2;
16 Vg=0.163;         //in m^3/kg
17 printf('At 12 bar, V2: %3.3f kJ/kg',V2);
18 printf('\n');
19 printf('As Vg>V2, steam is wet');
20 printf('\n');
21 x2=V2/Vg;
22 printf('The dryness fraction at 12 bars: %3.2f ',x2)
    ;
23 printf('\n');
24
25 Hf=798.6;           //in kJ/kg
26 Hfg=1986.2;        //in kJ/kg
27 H2=Hf+(x2*Hfg);
28 printf('The Final enthalpy of steam: %3.1f kJ/kg',H2
    );
29 printf('\n');

```

Scilab code Exa 4.11.1 Example 11

```

1 clc
2 clear
3
4 //At 20 degree Celcius
5 Cpw=4.187;          //in kJ/kg
6 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: %3.1 f 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
18       ',m);
18 printf('\n');

```

Scilab code Exa 4.14.1 Example 14

```
1  clc
2  clear
3
4  //Conditions at 10 bar
5  P=10;           //in bar
6  Tsat=179.9+273; //in K
7  Hf=762.8;      //in kJ/kg
8  Hfg=2015.3;    //in kJ/kg
9  Hg=2778.1;     //in kJ/kg
10 Vg=0.194;      //in m^3/kg
11 Sf=2.139;      //in kJ/kg K
12 Sg=6.623;      //in kJ/kg K
13 Sfg=4.448;     //in kJ/kg K
14 x=0.91;        //Dryness Fraction
15 m=3;           //in kg
16
17 //Now for wet steam
18 H=Hf+(x*Hfg);
19 H_final=m*H;
20 printf('The total Enthalpy: %3.1f kJ',H_final);
21 printf(' \n');
22 V=x*Vg;
23 U=H-(P*100*V);
24 U_final=m*U;
25 printf('The Internal Energy: %3.1f kJ',U_final);
26 printf(' \n');
27 S=Sf+(x*Sfg);
28 S_final=m*S;
29 printf('The Entropy: %3.3f kJ/K',S_final);
30 printf(' \n \n');
31
32 //Now Case 2
33 printf('Now for Case 2 \n');
34 Tsat=179.9+273; //in K
35 Tsup=200+273;   //in K
36 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
```

```

2 clear
3
4 //At 15 bar condition
5 Tsat=198.3+273;           //in K
6 m=7;                      //in kg
7 Hg=2792.2;               //in kJ/kg
8 Tsup=300+273;           //in K
9 Cps=2.1;                 //in kJ/kg K
10 H1=Hg+(Cps*(Tsup-Tsat));
11 Cpw=4.187;              //in kJ/kg K
12 H2=Cpw*50;
13 Q=m*(H1-H2);
14 printf('The total amount of heat required: %3.1f kJ',
        ,Q);
15 printf('\n');
16 Sg=6.445;                //in kJ/kg K
17 S2=Sg+(Cps*log(Tsup/Tsat));
18 Sf=0.704;                //in kJ/kg K
19 S1=Sf;
20 S=m*(S2-S1);
21 printf('The change in Entropy: %3.2f kJ/K',S);
22 printf('\n');

```

Scilab code Exa 4.16.1 Example 16

```

1 clc
2 clear
3
4 //Conditions at 10 bar
5 P=10;                     //in bar
6 Tsat=179.9+273;          //in K
7 Hf=762.8;                 //in kJ/kg
8 Hfg=2015.3;               //in kJ/kg
9 Hg=2778.1;                //in kJ/kg
10 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: %2.2 f 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: %2.2 f 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

```

```

7 Vg=0.215;           //in m^3/kg
8 Hf=742.8;          //in kJ/kg
9 Hfg=2031.1;        //in kJ/kg
10 Hg=2773.9;        //in kJ/kg
11 T2=250+273;       //in K
12 x=0.91;           //Dryness Fraction
13 V1=x*Vg;
14 V2=0.2696;        //From Steam Table
15 W=P*100*(V2-V1);
16 printf('The Work Output: %2.2 f kJ/kg',W);
17 printf('\n');
18 H1=Hf+(x*Hfg);
19 H2=2946.3;        //From steam table in kJ/kg
20 Q=H2-H1;
21 printf('The heat supplied to steam: %2.2 f kJ/kg',Q);
22 printf('\n');
23 U=Q-W;
24 printf('The internal energy of steam increases by:
    %2.2 f kJ/kg',U);
25 printf('\n');

```

Scilab code Exa 4.21.1 Example 21

```

1 clc
2 clear
3
4 //Conditions at 16 bar
5 P=16;              //in bar
6 Vov=0.015;        //Volume of Vessel
7 Mos=0.1;          //Mass of steam
8 SV=Vov/Mos;       //Specific Volume
9 Vg=0.124;         //in m^3/kg
10 Tsat=201.4+273;  //in K
11 Tsup=(SV/Vg)*Tsat;
12 printf('The temperature of steam: %2.2 f 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: %2.2 f 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: %2.2 f 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: %2.2 f kJ',W);
21 printf('\n');
22 H1=Hg;
23 H2=Hf+(x2*Hfg);
24 Q=m*(H2-H1);
25 printf('Change in Enthalpy: %2.2 f kJ',Q);
26 printf('\n');
27 U=(Q-W);
28 printf('Change in total Internal Energy: %2.2 f kJ',U
);
29 printf('\n');
30 S1=Sg;
31 S2=Sf+(x2*Sfg);
32 S=m*(S2-S1);
33 printf('Change in Entropy: %2.2 f 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: %2.2 f kJ',H);
54 printf('\n');
55
56 W=m*P1*100*Vg*(log(V02/V01));
57 printf('Total work done: %2.2 f kJ',W);
58 printf('\n');
59
60 U=H; //as P1 V1= P2 V2
61 Q=U+W;
62 printf('Change in Enthalpy: %2.2 f 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: %2.3 f kJ/K',S);
73 printf('\n');

```

Scilab code Exa 4.23.1 Example 23

```

1  clc
2  clear
3
4  //Initial conditions at 7 bar pressure
5  P1=7; //in bars
6  Vg1=0.273; //in m^3/kg
7  V1=Vg1; //in m^3/kg
8  Hg1=2763.5; //in kJ/kg
9  H1=Hg1;
10 Tsat=165+273; //in K
11 Sf=1.992; //in kJ/kg K
12 Sfg=4.716; //in kJ/kg K
13 Sg=6.708; //in kJ/kg K
14 n=1.1;
15
16 //Final conditions at 0.5 bar
17 P2=0.5; //in bars
18 V2=((P1*(V1^1.1))/P2)^(1/1.1); //using P(V)
    ^1.1=Constant
19
20 W=((P1*100*V1)-(P2*100*V2))/(n-1);
21 printf('Work Done: %3.2 f kJ',W);
22 printf('\\n');
23
24 Hf2=340.6; //in kJ/kg
25 Hfg2=2305.4; //in kJ/kg
26 Vg2=3.24; //in m^3/kg
27 x2=V2/Vg2; //Dryness Fraction
28
29 H2=Hf2+(x2*Hfg2);
30
31 U1=H1-(P1*100*V1);
32 U2=H2-(P2*100*V2);
33 U=U2-U1;
34 printf('Change in Internal Energy: %3.2 f kJ/kg',U);
35 printf('\\n');
36
37 Q=U+W; //From First law of

```

```

    Thermodynamics
38 printf('Heat Transferred: %3.2f kJ/kg',Q);
39 printf('\n');
40
41 S1=Sg;
42 //At 0.5 bar
43 Sf2=1.091;           //in kJ/kg K
44 Sfg2=6.503;         //in kJ/kg K
45 Sg2=7.594;         //in kJ/kg K
46 S2=Sf2+(x2*Sfg2);
47 S=S2-S1;
48 printf('Change in Entropy: %3.2f kJ/kg K',S);
49 printf('\n');

```

Scilab code Exa 4.24.1 Example 24

```

1  clc
2  clear
3
4  //At state 1
5  P1=20;           //in bar
6  V=2;
7  Vg1=0.0996;     //in m^3/kg
8  Tsat1=212.4+273; //in K
9  Tsup1=573;      //in K
10 V1=Vg1*(Tsup1/Tsat1);
11 m=V/V1;
12
13 //At state 2
14 V2=V1;
15 Vg2=V2;
16 P2=16.9;        //From Steam Table
17
18 //Calculations
19 Hg1=2799.5;     //in kJ/kg

```



```

20 Cps=2.1; //in kJ/kg K
21 H1=m*(Hg1+(Cps*(Tsup1-Tsat1)));
22 U1=H1-(P1*100*V);
23
24 Hg2=2795.5; //in kJ/kg from Steam table
25 H2=m*Hg2;
26 U2=H2-(P2*100*V);
27
28 Q=U2-U1;
29 printf('Heat Transferred: %3.1f kJ',Q);
30 printf('\n');
31
32 Sg1=6.341; //in kJ/kg K
33 S1=Sg1+(Cps*log(Tsup1/Tsat1));
34
35 S2=6.4022; //From Steam Table
36 S=m*(S2-S1);
37 printf('Change in Entropy: %3.3f kJ/K',S);
38 printf('\n');

```

Scilab code Exa 4.25.1 Example 25

```

1 clc
2 clear
3
4 //For Throttling process , H1=H2
5 //At 15 bar pressure
6 P1=15; //in bar
7 Hf1=844.9; //in kJ/kg
8 Hfg1=1947.3; //in kJ/kg
9 x1=0.73; //Dryness Fraction
10
11 //At 1 bar pressure
12 P2=1; //in bar
13 Hf2=417.5; //in kJ/kg

```

```

14 Hfg2=2258.0;           //in kJ/kg
15 Hg2=2675.5;          //in kJ/kg
16 H2=2266.4;           //in kJ/kg
17
18 H1=Hf1+(x1*Hfg1);
19 x2=(H2-Hf2)/Hfg2;
20
21 //Now if x1=0.95
22 H1=Hf1+(0.95*Hfg1);
23 H2=H1;
24
25 //At 1 bar
26 Hg=2675.5;
27 Cps=2.1;
28 x=0.93;               //New dryness fraction
29 T=(H2-Hg)/Cps;       //Temperature difference
30 Tsat=99;              //in Celcius
31 Tsup=Tsat+T;
32 printf('Temperature of superheated steam: %3.1f
    Celcius ',Tsup);
33 printf('\n');
34
35 //Now at 15 bar
36 Sf=2.315;             //in kJ/kg K
37 Sfg=4.130;           //in kJ/kg K
38 Sg=6.445;            //in kJ/kg K
39 S1=Sf+(x*Sfg);
40
41 //Now at 1 bar
42 Sg1=7.360;            //in kJ/kg K
43 S2=Sg1+(Cps*log((Tsup+273)/(Tsat+273)));
44 S=S2-S1;
45 printf('Change in Entropy: %3.2f kJ/kg K',S);
46 printf('\n');

```

Scilab code Exa 4.26.1 Example 26

```
1  clc
2  clear
3
4  //Heat lost by Steam=Heat gained by water and
   calorimeter
5
6  ms=2;                //in kg
7  Hf1=697.2;          //in kJ/kg
8  Hfg1=2066.3;        //in kJ/kg
9  Hf2=146.7;          //in kJ/kg
10 T2=35;              //in Celcius
11 T1=15;              //in Celcius
12 mg=56;              //in kg
13 Cpw=4.187;          //in kJ/kg K
14 H_gained=mg*Cpw*(T2-T1);
15 x=((H_gained)/2)+(Hf2-Hf1))/Hfg1;
16 printf('The dryness fraction is %2.2f ',x);
17 printf('\n');
```

Scilab code Exa 4.27.1 Example 27

```
1  clc
2  clear
3
4  //Calculating dryness fraction
5  Ms=10;
6  Mw=1;
7  x=(100*Ms)/(Ms+Mw);
8  printf('The Dryness Fraction of steam is %2.1f
   percent ',x);
9  printf('\n');
```

Scilab code Exa 4.28.1 Example 28

```
1  clc
2  clear
3
4  P1=11;           //in bar
5  P2=1.1;         //in bar
6  T2=130+273;     //in K
7  Cps=2.1;        //in kJ/kg K
8
9  //At 11 bar
10 Hf1=781.3;       //in kJ/kg
11 Hfg1=2000.4;    //in kJ/kg
12
13 //At 1.1 bar
14 Hg2=2679.7;     //in kJ/kg
15 Tsat=102.3+273; //in K
16 Tsup=130+273;
17
18 //Now for throttling process , H1=H2
19 H2=Hg2+(Cps*(Tsup-Tsat));
20 x=((H2-Hf1)*100)/Hfg1;
21 printf('The dryness fraction of steam: %2.1f',x);
22 printf('\n');
```

Scilab code Exa 4.29.1 Example 29

```
1  clc
2  clear
3
4  //Combined seperating and throttling calorimeter
5  Ms=5;           //in kg
```

```

6 Mw=0.5;           //in kg
7 Cps=2.1;         //in kJ/kg K
8 Man=166.8;       //in mm of Hg
9 Bar=733.6;       //in mm of Hg
10
11 x1=Ms/(Ms+Mw);
12 P=Man+Bar;
13 P_bar=(1.01325*P)/760;      //Pressure in bar
14
15 //From steam table
16 Hf1=742.8;         //in kJ/kg
17 Hfg1=2031.1;      //in kJ/kg
18 Tsat=104.8+273;   //in K
19 Tsup=110.3+273;   //in K
20 Hg=2683.5;        //in kJ/kg
21
22 H2=Hg+(Cps*(Tsup-Tsat));
23 x2=(H2-Hf1)/Hfg1;
24 x=x1*x2;
25 printf('The dryness fraction of steam: %2.3f',x);
26 printf('\n');

```

Scilab code Exa 4.30.1 Example 30

```

1 clc
2 clear
3
4 //Combined seperating and throttling calorimeter
5
6 Mw=8;           //in kg
7 M=63;          //in kg
8 Ms=M-Mw;       //in kg
9 P1=81.5;       //Pressure after throttling
                in mm
10 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

```

```

10 Sf2=1.7327;           //in kJ/kg K
11 Sg2=6.9358;         //in kJ/kg K
12 Vg2=0.5173;         //in m^3/kg
13
14 //Now at 0.36 bar pressure
15 Vg3=4.408;           //in m^3/kg
16
17 S1=Sf1+(x1*(Sg1-Sf1));
18
19 //As process is adiabatic
20 S2=S1;
21
22 //From steam table , Sg=6.9358 > S2
23
24 x2=(S2-Sf2)/(Sg2-Sf2);
25 V2=x2*Vg2;
26
27 //As volume remains constant
28 V3=V2;
29 x3=V3/Vg3;
30 printf('The dryness fraction of steam: %2.3f',x3);
31 printf('\n');

```

Scilab code Exa 4.32.1 Example 32

```

1  clc
2  clear
3
4  //At 10 bar pressure
5  m=1/(0.9*0.194);
6
7  Hf1=762.6;           //in kJ/kg
8  x1=0.9;             //Dryness Fraction
9  Hfg1=2013.6;        //in kJ/kg
10 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: %2.1 f 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: %2.4 f kJ',x);
24 printf('\n');
```

Scilab code Exa 4.35.1 Example 35

```
1  clc
```

```

2  clear
3
4  V=0.15;           //in m^3
5  P=4;             //in bar
6  x=0.8;           //Dryness fraction
7
8  //Now at 4 bar pressure
9  P=4;             //in bar
10 Vg=0.463;        //in m^3/kg
11
12 SV=x*Vg;
13 Mos=V/SV;        //Mass of Steam
14
15 //Now if Volume is 1 m^3
16
17 Ms=1/SV;         //in kg
18 //At 4 bar pressure
19 Hf=604.7;        //in kJ/kg
20 Hfg=2133.8;      //in kJ/kg
21 H=Ms*(Hf+(x*Hfg));
22 printf('Enthalpy of 1 m^3 steam: %2.2f kJ',H);
23 printf('\n');

```

Scilab code Exa 4.36.1 Example 36

```

1  clc
2  clear
3
4  P1=9;            //in bar
5  P2=1;            //in bar
6  T2=115+273;     //in K
7  m=1.8;           //in kg
8  m1=0.2;          //in kg
9  x1=m/(m+m1);    //Dryness fraction
10

```

```

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');
25 printf('Enthalpy of steam: %2.2f kJ',H);
26 printf('\n');
27
28 U=H-(P*100*Vg);
29 printf('Internal Energy of steam: %2.2f kJ',U);
30 printf('\n');
31
32 //Case 3
33 Tsup=300+273;           //in K
34 Tsat=179.9+273;       //in K
35 H=Hg+(Cps*(Tsup-Tsat));
36 printf('\n \nCase 3: When steam is superheated to
    300 C \n \n');
37 printf('Enthalpy of steam: %2.2f kJ',H);
38 printf('\n');
39
40 Vsup=(Tsup/Tsat)*Vg;
41 U=H-(P*100*Vsup);
42 printf('Internal Energy of steam: %2.2f kJ',U);
43 printf('\n');

```

Scilab code Exa 4.39.1 Example 39

```

1  clc
2  clear
3
4  Ms=5;           //in kg
5  P=5;           //in bar
6  Tsup=250+273; //in K
7  Cps=2.1;       //in kJ/kg K
8  Tf=30;         //in C
9  Cpw=4.187;     //in kJ/kg K
10 H1=Cpw*Tf;
11

```

```

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 m3/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: %3.1 f 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: %3.2 f kJ/kg',U);
32 printf('\n');
33
34 Q=U+W;
35 printf('Heat transferred during the process: %3.2 f
   kJ/kg',Q);
36 printf('\n');

```

Chapter 5

Steam Boilers

Scilab code Exa 5.1.1 Example 1

```
1  clc
2  clear
3
4  Mf=1300;           //in kg
5  Ma=13000;         //in kg
6  P=7;              //in bar
7  Cpw=4.187;        //in kJ/kg K
8  CV=30000;         //in kJ/kg
9  x=0.95;           //Dryness Fraction
10 Tfw=40;           //in C
11
12 Hfw=Tfw*Cpw;
13
14 //At 7 bar
15 Hf=697.2;          //in kJ/kg
16 Hfg=2066.3;        //in kJ/kg
17
18 H=Hf+(x*Hfg);
19 Ms=Ma/Mf;
20
21 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'
18 ,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

```

1  clc
2  clear
3
4  Ma=10000;           //in kg/hr
5  P=7;               //in bar
6
7  Tfw=40;            //in C
8  Hfw=167.6;         //in kJ/kg
9  H=2763.5;          //in kJ/kg
10
11 Q=Ma*(H-Hfw)/60;   //Heat per minute
12 SA=Q/2720;         //Heating surface area
    required
13 printf('Heating surface area required: %3.1f m^2',SA
    );
14 printf('\n');
15
16 GA=SA/25;
17 printf('Grate area required: %3.1f m^2',GA);
18 printf('\n');

```

Scilab code Exa 5.6.1 Example 6

```

1  clc
2  clear
3
4  Ma=2400;           //in kg
5  Mf=240;            //in kg
6  P=12;              //in bar
7  CV=33500;          //in kJ/kg
8  Tfw=120;           //in C
9  Cpw=4.187;
10 Hfw=Cpw*Tfw;
11 H=2784.8;           //in kJ/kg
12 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

```
1  clc
2  clear
3
4  Hf=762.8;           //in kJ/kg
5  Hfg=2015.3;       //in kJ/kg
6  x=0.95;           //Dryness Fraction
7  Ma=1000;
8  Eff=0.75;
9  CV=31000;
10
11 H=Hf+(x*Hfg);
12 Cpw=4.187;
13 T=50;
14
15 Hfw=Cpw*T;
16 Q=Ma*(H-Hfw);
17
18 Mf=Q/(Eff*CV);
19 y=Mf/0.9;
20
21 Eff1=(Q*100)/(y*CV);
22 printf('Efficiency of Boiler and grate: %3.1f
    percent ',Eff1);
23 printf('\n');
```

Scilab code Exa 5.9.1 Example 9

```
1  clc
2  clear
3
```

```

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

```
1  clc
2  clear
3
4  Ms=7.3;           //kg/kg of fuel
5  Tfw=46;          //in C
6  P=10;            //in bar
7  FOE=1.17;        //Factor of Evaporation
8  Eff=0.79;
9  Me=FOE*Ms;
10 printf('Equivalent Evaporation: %3.2f kg/kg of coal'
        ,Me);
11 printf('\n');
12
13 Hfw=192.6;        //in kJ/kg
14 Hg=2778.1;        //in kJ/kg
15 Tsat=179.9;      //in C
16 Cps=2.1;         //in kJ/kg K
17 H=(2257*FOE)+Hfw;
18 Tsup=((H-Hg)/Cps)+Tsat;
19 printf('Temperature of Superheated Steam: %3.1f C',
        Tsup);
20 printf('\n');
21
22 CV=(Ms*(H-Hfw))/Eff;
23 printf('Calorific Value: %3.1f kJ/kg',CV);
24 printf('\n');
```

Scilab code Exa 5.13.1 Example 13

```
1  clc
```

```

2  clear
3
4  Ma=18000;           //in kg/hr
5  P=10;              //in bar
6  x=0.97;           //Dryness Fraction
7  Tfw=40;           //in C
8  Mf=2050;          //in kg/hr
9  CV=28000;         //kJ/kg
10
11 //At 10 bar
12 Hf1=762.8;
13 Hfg1=2015.3;
14 H=Hf1+(x*Hfg1);
15
16 Hfw=167.6;
17
18 Eff=(Ma*100*(H-Hfw))/(Mf*CV);
19 printf('Boiler efficiency: %3.2f Percent',Eff);
20 printf('\n');
21
22 EA=((Ma/Mf)*(H-Hfw))/2257;
23 printf('Equivalent Evaporation: %3.2f kg/kg of coal',
24        ,EA);
24 printf('\n');

```

Scilab code Exa 5.14.1 Example 14

```

1  clc
2  clear
3
4  Ma=18000;           //in kg/hr
5  P=12;              //in bar
6  x=0.97;           //Dryness Fraction
7  CV=27400;         //in kJ/kg
8  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 ',
14        ASE);
14 printf('\n');
15
16 P2=P1*(r)^G;
17 printf('Pressure at end of Compression is %3.2f Bar ',
18        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
```

```

4 T1=57+273;           //in K
5 T2=603+273;         //in K
6 T3=1950+273;        //in K
7 T4=870+273;         //in K
8 G=1.4;
9 P1=1;                //in bar
10 Cp=1.005;
11 Cv=0.718;
12
13 P2=P1*((T2/T1)^((G)/(G-1)));
14 printf('Maximum Pressure attained is %2.1f bar',P2);
15 printf('\n');
16
17 Qs=Cp*(T3-T2);      //Heat Supplied
18 Qr=Cv*(T4-T1);     //Heat Rejected
19 Eff=100*(1-(Qr/Qs));
20 printf('Efficiency is %2.0f Percent',Eff);
21 printf('\n');

```

Scilab code Exa 6.5.1 Example 5

```

1 clc
2 clear
3
4 V2=0.2;              //in cm^3
5 V3=V2;
6 Vc=V2;
7
8 Vs=1.2;              //in cm^3
9 V1=V2+Vs;
10 G=1.4;
11
12 r=(V1/V2);
13 Eff=100*(1-(1/(r^(G-1))));
14 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

```

1  clc
2  clear
3
4  D=10;           //Diameter in cm
5  L=15;           //Length in cm
6  Vs=(22/7)*(1/4)*D*D*L;           //in cm^3
7  Vc=250;        //in cm^3
8  V2=Vc;
9  V1=Vs+Vc;
10 r=V1/V2;
11 G=1.4;
12
13 Eff=100*(1-(1/(r^(G-1)))));
14 printf('Efficiency is %2.1f Percent ',Eff);
15 printf('\n');

```

Scilab code Exa 6.9.1 Example 9

```

1  clc
2  clear
3
4  T3=15+273;     //in K
5  T4=T3;
6  P3=1.1;        //in bar
7  P4=4;          //in bar
8  P1=12;         //in bar
9  N=150;         //in rpm
10 G=1.4;
11
12 T1=T4*((P1/P4)^((G-1)/G));
13 Eff=100*(1-(T4/T1));
14 printf('The Efficiency is %3.2f Percent ',Eff);
15 printf('\n');
16
17 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

```
1  clc
2  clear
3
4  r=6;           //Compression Ratio
5  T1=20+273;    //in K
6  G=1.4;
7  Cv=0.718;
8  Qs=1900;
9  Eff=100*(1-(1/(r^(G-1))));
10 printf('The Efficiency is %3.2f Percent',Eff);
11 printf('\n');
12
13 T2=T1*(r^(G-1));
14 printf('The value of T2 is %3.0f K',T2);
15 printf('\n');
16
17 T3=(Qs/Cv)+T2;
18 printf('The value of T3 is %3.0f K',T3);
19 printf('\n');
20
21 T4=T3/(r^(G-1));
22 printf('The value of T4 is %3.0f K',T4);
23 printf('\n');
24
25 W=Qs*Eff/100;
26 printf('The Work Output is %3.0f kJ/kg',W);
27 printf('\n');
```

Scilab code Exa 6.13.1 Example 13


```

1  clc
2  clear
3
4  D=0.1;           //Diameter
5  L=0.12;         //Length
6  V=(22/7)*(1/4)*D*D*L;
7  T1=19+273;
8  r=6.5;          //Compression ratio
9  P1=1;           //in bar
10 G=1.4;          //Gamma
11 Vs=9.425*(10^-4);
12 Vc=Vs/(r-1);
13 V1=Vc+Vs;
14 printf('V1= %3.5 f m^3 ',V1);
15 printf('\\n');
16
17 V2=Vc;
18 V3=Vc;
19 P2=P1*(r^G);
20 printf('P2= %3.1 f bar ',P2);
21 printf('\\n');
22
23 T2=T1*(r^(G-1));
24 printf('T2= %3.1 f K',T2);
25 printf('\\n');
26
27 //For process 2-3
28 Qs=1900;
29 Cv=0.718;
30 T3=(Qs/Cv)+T2;
31 printf('T3= %3.1 f K',T3);
32 printf('\\n');
33
34 P3=P2*(T3/T2);
35 printf('P3= %3.1 f bar ',P3);
36 printf('\\n');
37
38 //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= %2.1 f K',T2);
30 printf('\n');
31
32 T3=Z*T2;
33 printf('T3= %2.1 f K',T3);
34 printf('\n');
35
36 P3=P2;
37 P4=P3*((V3/V1)^G);
38 printf('P4= %2.1 f bar',P4);
39 printf('\n');
40
41 T4=T3*((V3/V1)^(G-1));
42 printf('T4= %2.1 f 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: %2.1 f 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= %2.1 f 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= %2.2 f kW',EP);
62 printf('\n');

```

Scilab code Exa 6.16.1 Example 16

```
1  clc
2  clear
3
4  r=19;           // Compression Ratio
5  P1=1;           //in bar
6  T1=17+273;     //in K
7  Qs=730;        //in kJ/cycle
8  G=1.4;
9
10 //For process 1-2
11 m=1;           //in kg
12 R=0.287;       //Universal Gas Constant
13 V1=(m*R*T1)/(P1*100);
14 printf('V1= %2.4 f m^3/kg',V1);
15 printf('\n');
16
17 V2=V1/r;
18 printf('V2= %2.4 f m^3/kg',V2);
19 printf('\n');
20
21 P2=P1*(r^G);
22 printf('P2= %2.1 f bar',P2);
23 printf('\n');
24
25 T2=T1*(r^(G-1));
26 printf('T2= %2.1 f K',T2);
27 printf('\n');
28
29 //For Process 2-3
30 Cv=0.718;
31 T3=(Qs/(Cv*m))+T2;
32 printf('T3= %2.1 f K',T3);
```

```

33 printf( '\n' );
34
35 P3=P2;
36 printf( 'P3= %2.1 f bar ',P3);
37 printf( '\n' );
38
39 //As pressure is constant
40 V3=(T3/T2)*V2;
41 printf( 'V3= %2.4 f m^3/kg ',V3);
42 printf( '\n' );
43
44 //For process 3-4
45 V4=V1;
46 T4=T3*((V3/V4)^(G-1));
47 printf( 'T4= %2.1 f K ',T4);
48 printf( '\n' );
49
50 P4=P3*((V3/V4)^G);
51 printf( 'P4= %2.2 f bar ',P4);
52 printf( '\n' );
53
54 Cp=1.005;
55
56 W=((Cp)*(T3-T2))-((Cv*(T4-T1)));
57 printf( 'Work Done= %2.1 f kJ/kg ',W);
58 printf( '\n' );
59
60 Eff=100*(W/(Cp*(T3-T2)));
61 printf( 'Efficiency= %2.2 f Percent ',Eff);
62 printf( '\n' );
63
64 Pm=W/(V1-V2);
65 printf( 'Mean Effective Pressure= %2.2 f kPa ',Pm);
66 printf( '\n' );

```

Scilab code Exa 6.17.1 Example 17

```
1  clc
2  clear
3
4  r=19;           //Compression Ratio
5  Re=9.1;        //Expansion Ratio
6  Z=r/Re;
7  G=1.4;
8  Eff=100*(1-((1/(r^(G-1)))*(1/G)*((Z^G)-1)/(Z-1)));
9  printf('Efficiency: %2.2f Percent',Eff);
10 printf('\n');
```

Scilab code Exa 6.18.1 Example 18

```
1  clc
2  clear
3
4  D=16;           //in cm
5  L=24;           //in cm
6  Vc=340;
7  V2=Vc;
8  G=1.4;
9
10 Vs=(22/7)*(1/4)*D*D*L;
11 V1=Vs+Vc;
12 r=V1/V2;
13
14 //Cut-off is 6% of the stroke
15 Co1=0.06;
16
17 V3=(Co1*(V1-V2))+V2;
18 Z=V3/V2;
19 x=(Z^G)-1;
20 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
```

```

7 T3=1431+273;           //in K
8 G=1.4;
9 T2=T1*[r^(G-1)];
10 m=1;
11 R=0.287;
12 V1=(m*R*T1)/(P1*100);
13 V2=V1/r;
14
15 //For Constant Pressure Process 2-3
16 V3=V2*(T3/T2);
17 Z=V3/V2;
18 Eff=100*(1-((1/(r^(G-1)))*(1/G)*((Z^G)-1)/(Z-1)));
19 printf('Efficiency is %2.1f Percent',Eff);
20 printf('\n');
21
22 Cp=1.005;
23 Qs=Cp*(T3-T2);
24 W=Qs*Eff/100;
25 Vs=V1-V2;
26 Pm=W/Vs;
27 printf('Effective Mean Pressure %2.1f kPa',Pm);
28 printf('\n');

```

Scilab code Exa 6.24.1 Example 24

```

1 clc
2 clear
3
4 r=8;
5 T1=310;           //in K
6 T3=1600;         //in K
7 G=1.4;
8 Cv=0.717;
9
10 //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

```

1  clc
2  clear
3
4  T2=293;      //in K
5  Eff=0.7;
6  T1=T2/(1-Eff);
7  printf('T1= %2.1 f K',T1);
8  printf('\\n');

```

Scilab code Exa 6.28.1 Example 28

```

1  clc
2  clear
3
4  T1=330;      //in K
5  T2=876;      //in K
6  T3=2223;     //in K
7  T4=1143;     //in K
8  P1=1;        //in bar
9  G=1.4;
10
11 Cv=0.718;
12 Cp=1.005;
13 Eff=100*[1-((Cv*(T4-T1))/(Cp*(T3-T2)))]);
14 printf('Efficiency is %2.1 f Percent',Eff);
15 printf('\\n');
16
17 //For Process 1-2
18 P2=P1*[(T2/T1)^(G/(G-1))];
19 printf('Maximum Pressure %2.1 f bar',P2);
20 printf('\\n');

```

Scilab code Exa 6.29.1 Example 29

```

1  clc
2  clear
3
4  T1=25+273;           //in K
5  T3=1500+273;        //in K
6  Qa=900;             //in kJ/kg
7  Cv=0.718;
8  G=1.4;
9
10 T2=T3-(Qa/Cv);
11 r=(T2/T1)^(1/(G-1));
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
19 Px=r^G;             //Max Pressure
20 Py=T3/T2;           //1/Min Pressure
21 P=Px*Py;
22 printf('Pressure Ratio %2.1f ',P);
23 printf('\\n');

```

Scilab code Exa 6.30.1 Example 30

```

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  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
```

```

6 Eff=0.85;           //Mechanical Efficiency
7 Pmb=5;             //in bar
8 LD=1.5;
9 Pm=Pmb/Eff;
10 N=800;
11 nx=N/2;
12
13 //Length=1.5*D
14 D=[[IP*60*4]/[Pm*100*(22/7)*LD*nx*n]]^(1/3);
15 printf('D= %3.4 f mm',D*100);
16 printf('\n');
17 L=D*LD;
18 printf('L= %3.4 f mm',L*100);
19 printf('\n');

```

Scilab code Exa 7.3.1 Example 3

```

1 clc
2 clear
3
4 BP=22;             //Brake Power
5 Eff=0.85;         //Mechanical Efficiency
6 IP=BP/Eff;
7 mf=6.5;
8 CV=30000;         //Calorific Value
9 Ebth=BP/((mf/3600)*CV);
10 printf('Brake Thermal Eff= %3.1 f Percent ',Ebth*100);
11 printf('\n');
12
13 Eith=IP/((mf/3600)*CV);
14 printf('Indicated Thermal Eff= %3.1 f Percent ',Eith
    *100);
15 printf('\n');
16
17 BSFC=mf/BP;

```

```
18 printf('BSFC= %3.1 f 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= %3.0 f mm',D*1000);
14 printf('\n');
15 L=D*LD;
16 printf('L= %3.0 f 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;
```

```

9 G=1.4;
10 Ea=[1-(1/(r^(G-1)))];
11 Eith=0.3;
12 Erel=Eith/Ea;
13 printf('Erel= %3.2 f Percent ',Erel*100);
14 printf('\n');
15
16 Pm=500;          //in kPa
17 n=1000/2;
18 IP=(Pm*Vs*n)/60;
19 printf('IP= %3.2 f kW',IP);
20 printf('\n');

```

Scilab code Exa 7.6.1 Internal Combustion Engines

```

1 clc
2 clear
3
4 Pm=600;
5 A=(22/7)*(1/4)*0.11*0.11*0.14;
6 n=1000;
7 IP=(Pm*A*n)/60;
8 Em=0.8;
9 BP=Em*IP;
10 printf('BP= %3.2 f kW',BP);
11 printf('\n');

```

Scilab code Exa 7.7.1 Example 7

```

1 clc
2 clear
3
4 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= %3.2 f 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= %3.0 f mm',D*1000);
18 printf('\n');
19
20 L=DL*D;
21 printf('L= %3.0 f mm',L*1000);
22 printf('\n');
23
24 Ebth=BP/(Mf*CV/3600);

```



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

```

8 N=1000;
9 Eith=0.32;
10 Vs=(22/7)*D*D*L*(1/4);
11 Vc=700;
12 G=1.4;
13 r=(Vs+Vc)/Vc;
14 Ea=[1-(1/(r^(G-1)))];
15 Er=Eith/Ea;
16 printf('Relative Efficiency= %3.2 f Percent ',Er*100);
17 printf('\n');
18
19 IP=(Pm*100*Vs*(10^-6)*N)/60;
20 printf('IP= %3.2 f KW',IP);
21 printf('\n');

```

Scilab code Exa 7.11.1 Example 11

```

1 clc
2 clear
3
4 T=50;
5 Vst=870;
6 N=300;
7 Pm=10;
8 n=N/2;
9
10 BP=(2*(22/7)*N*T)/(60*1000);
11 IP=(Pm*100*Vst*(10^-6)*N)/(60*2);
12 Em=BP/IP;
13 printf('Mechanical Efficiency= %3.2 f Percent ',Em
    *100);
14 printf('\n');

```

Scilab code Exa 7.12.1 Example 12

```
1  clc
2  clear
3
4  Pm=7;
5  A=(22/7)*(1/4)*((0.15/1.25)^2);
6  n=900;
7  L=0.15;
8  N=2
9  IP=(Pm*100*A*L*n*N)/(60*2);
10 printf('IP= %3.2 f kW',IP);
11 printf('\n');
```

Scilab code Exa 7.13.1 Example 13

```
1  clc
2  clear
3
4  N=900;
5  D=0.1;
6  L=0.14;
7  Mf=2.1;
8  CV=42000;
9  Pm=7.5;
10 Vc=0.15;
11 G=1.4;
12 A=(22/7)*(1/4)*D*D;
13 IP=(Pm*100*A*L*N*2)/(60*2);
14 Eith=(IP*3600)/(Mf*CV);
15 printf('Eith= %3.1 f Percent',Eith*100);
16 printf('\n');
17
18 r=(1+0.15)/(0.15);
19 Ea=1-[1/(r^(G-1))];
```

```
20 Er=Eith/Ea;
21 printf('Relative Efficiency= %3.2 f 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= %3.0 f mm',D*1000);
14 printf('\n');
15 L=LD*D;
16 printf('L= %3.0 f 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;
```

```

8 LD=1.2;
9 Pm=10;
10 Em=0.81;
11 Mf=65;
12 CV=42000;
13 IP=BP/Em;
14 D=[[IP*60*2*4]/[Pm*100*(22/7)*(1.2*(N)*NOC)]]^(1/3);
15 printf('D= %3.0 f mm',D*1000);
16 printf('\n');
17
18 L=LD*D;
19 printf('L= %3.0 f mm',L*1000);
20 printf('\n');
21
22 Eith=(IP*3600)/(Mf*CV);
23 printf('Eith= %3.2 f Percent',Eith*100);
24 printf('\n');
25
26 Ebth=Eith*Em;
27 printf('Ebth= %3.2 f Percent',Ebth*100);
28 printf('\n');

```

Scilab code Exa 7.16.1 Example 16

```

1 clc
2 clear
3
4 IP=42;
5 FP=7;
6 ES=1800;
7
8 BP=IP-FP;
9
10 Em=BP/IP;
11 printf('Mechanical Efficiency= %3.0 f Percent',Em

```

```

    *100);
12 printf('\n');
13
14 BSFC=0.3;
15 CV=43000;
16
17 Ebth=3600/(BSFC*CV);
18 printf('Brake Thermal Efficiency= %3.0f Percent ',
    Ebth*100);
19 printf('\n');
20
21 Eith=Ebth/Em;
22 printf('Indicated Thermal Efficiency= %3.0f Percent ',
    ,Eith*100);
23 printf('\n');

```

Scilab code Exa 7.17.1 Example 17

```

1  clc
2  clear
3
4  D=0.3;
5  L=0.45;
6  N=300;
7  Pimep=6;
8  F=1.5;
9  Reff=(180+4)/2;
10
11 IP=(Pimep*100*L*(22/7)*(1/4)*(D*D)*N)/(2*60);
12 printf('Indicated Power= %3.2f kW',IP);
13 printf('\n');
14
15 BP=(2*(22/7)*N*F*Reff)/6000;
16 printf('Brake Power= %3.2f kW',BP);
17 printf('\n');

```

```

18
19 Em=BP/IP;
20 printf('Mechanical Efficiency= %3.2 f 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= %3.2 f 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= %3.2 f kW',IP);
20 printf('\n');
21
22 Em=BP/(IP*1000);
23 printf('Mechanical Efficiency= %3.2 f 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= %3.2 f 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= %3.2 f kW',BP);
23 printf('\n');
24
25 Em=BP/IP;
26 Eith=(IP*3600)/(Mf*CV);
27 printf('Em= %3.2 f Percent',Em*100);
28 printf('\n');
29 printf('Eith= %3.2 f 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;

```

```

8  Mf=4;
9  CV=43000;
10 Em=0.7;
11 Reff=9.81*(D/2);
12
13 BP=[2*(22/7)*N*(W-S)*Reff]/(60*1000);
14 Ebth=(BP*3600)/(Mf*CV);
15 printf('Ebth= %3.2 f Percent ',Ebth*100);
16 printf('\n');
17
18 Eith=Ebth/Em;
19 printf('Eith= %3.2 f Percent ',Eith*100);
20 printf('\n');

```

Scilab code Exa 7.22.1 Example 22

```

1  clc
2  clear
3
4  T=640;
5  D=0.21;
6  N=350;
7  L=0.28;
8  Pm=5.6;
9  Mf=8.16;
10 CV=42705;
11
12 BP=[2*(22/7)*N*T]/60000;
13 printf('Brake Power= %3.2 f kW',BP/1000);
14 printf('\n');
15
16 A=(22/7)*(1/4)*D*D;
17 IP=(Pm*100*A*L*N)/60;
18
19 Em=BP/IP;

```

```

20 printf('Em= %3.2 f Percent ',Em*100);
21 printf('\n');
22
23 Eith=(IP*3600)/(Mf*CV);
24 printf('Eith= %3.2 f Percent ',Eith*100);
25 printf('\n');
26
27 Ebth=(BP*3600)/(Mf*CV);
28 printf('Ebth= %3.2 f Percent ',Ebth*100);
29 printf('\n');
30
31 BSFC=Mf/BP;
32 printf('BSFC= %3.2 f kg/kWh', BSFC);
33 printf('\n');

```

Scilab code Exa 7.23.1 Example 23

```

1  clc
2  clear
3
4  IP=37;
5  FP=6;
6  BSFC=0.28;
7  CV=44300;
8
9  BP=IP-FP;
10 Em=(IP-FP)/IP;
11 printf('Em= %3.2 f Percent ',Em*100);
12 printf('\n');
13
14 Mf=BSFC*BP;
15 Ebth=(BP*3600)/(Mf*CV);
16 printf('Ebth= %3.2 f Percent ',Ebth*100);
17 printf('\n');
18

```

```
19 Eith=Ebth/Em;
20 printf('Eith= %3.2 f 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= %3.2 f kW',IP);
19 printf('\n');
20
21 BP=(2*(22/7)*N*(W-S)*Reff)/60000;
22 printf('Brake Power= %3.2 f kW',BP);
23 printf('\n');
24
25 Em=BP/IP;
26 printf('Em= %3.2 f Percent ',Em*100);
27 printf('\n');
28
29 Ebth=(BP*3600)/(Mf*CV);
```

```

30 printf('Ebth= %3.2 f Percent ',Ebth*100);
31 printf('\n');
32
33 Eith=Ebth/Em;
34 printf('Eith= %3.2 f Percent ',Eith*100);
35 printf('\n');
36
37 G=1.4;
38 Ea=1-[1/(r^(G-1))];
39 printf('Ea= %3.2 f Percent ',Ea*100);
40 printf('\n');
41
42 Er=Ebth/Ea;
43 printf('Er= %3.2 f 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= %3.2 f kW',BP);
14 printf('\n');
15
16 Mf=(BP/(Ebth*CV));
17 printf('Mass Flow Rate= %3.2 f 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= %2.2 f 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= %2.1 f kW',IP*100);
16 printf('\n');
17
18 BP=IP/(Et*Em);
19 printf('Brake Power= %2.1 f kW',BP*100);
20 printf('\n');

```

Scilab code Exa 8.4.1 Example 4

```
1  clc
2  clear
3
4  n=1.35;
5  P1=1.013;
6  V1=1/60;
7  P2=7;
8  Et=0.85;
9  Em=0.9;
10
11 IP=[n/(n-1)]*[P1*100*V1]*[((P2/P1)^((n-1)/n))-1];
12 printf('Indicated Power= %2.1 f kW',IP);
13 printf('\n');
14
15 BP=IP/(Et*Em);
16 printf('Brake Power= %2.1 f kW',BP);
17 printf('\n');
```

Scilab code Exa 8.5.1 Example 5

```
1  clc
2  clear
3
4  n=1.2;
5  P1=1;
6  P2=6;
7  Vs=1.5/60;
8
9  IP=[n/(n-1)]*[P1*100*Vs]*[((P2/P1)^((n-1)/n))-1];
```

```

10 printf('Indicated Power= %2.1 f kW',IP);
11 printf('\n');
12 MP=6.55;
13 Em=IP/MP;
14 printf('Mechanical Efficiency= %2.1 f 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= %2.1 f kW',IP);
12 printf('\n');
13
14 T1=288;
15 T2=T1*[(P2/P1)^((n-1)/n)];
16 printf('Delivery Temperature= %2.0 f K',T2);
17 printf('\n');
18
19 printf('Swept Volume= %2.4 f m^3 ',Vs);
20 printf('\n');

```

Scilab code Exa 8.7.1 Example 7

```

1  clc
2  clear
3
4  P1=1;
5  P2=10;
6  Vs=0.015;
7  FAD=3;
8  Vc=Vs*0.06;
9  n=1.3;
10 T1=20+273;
11
12 IP=[n/(n-1)]*[P1*100*3]*[((P2/P1)^(n-1)/n))-1];
13 printf('Indicated Power= %2.1 f kW',IP/60);
14 printf('\n');
15
16 V4=Vc*[(P2/P1)^(1/n)];
17 V1=Vs+Vc;
18 V14=0.0107;
19 RS=3/V14;
20 printf('Rotation Speed= %2.0 f RPM',RS);
21 printf('\n');
22 Tf=288;
23 Pf=101.325;
24 Vf=[P1*100*(FAD)*Tf]/[T1*Pf];
25 printf('Vf= %2.4 f m^3/min',Vf);
26 printf('\n');
27
28 Mcd=V1/(V14);
29 printf('Mcd= %2.1 f ',Mcd);
30 printf('\n');

```

Scilab code Exa 8.8.1 Example 8

```

1  clc
2  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= %2.4 f m^3/cycle ',Vf);
20 printf('\n');
21 printf('Mc/Md= %2.2 f ',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= %2.2 f 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= %2.0 f mm',D*1000);
15 printf('\n');
16 printf('L= %2.0 f mm',L*1000);
17 printf('\n');

```

Scilab code Exa 8.11.1 Example 11

```

1  clc
2  clear
3
4  P1=1;
5  P2=16;
6  n=1.3;
7  LN=100;
8  N=350;
9  IP=30;
10 Ev=0.95;
11
12 L=LN/N;
13 x=[((P2/P1)^((n-1)/n))-1];
14 V14=[IP*(n-1)*60]/[n*P1*100*x*N];
15 Vs=V14/Ev;
16 D2=Vs*4/[(22/7)*L];
17 D=D2^0.5;
18 printf('D= %2.0 f mm',D*1000);
19 printf('\n');
20 printf('L= %2.0 f mm',L*1000);
21 printf('\n');

```

Scilab code Exa 8.12.1 Example 12

```

1  clc
2  clear
3
4  D=0.2;
5  L=0.3;
6  Vs=(22/7)*(1/4)*D*D*L;
7  Vc=0.04*Vs;
8
9  V3=Vc;
10 P2=9;
11 P1=1;

```

```

12 n=1.3;
13 V4=V3*[(P2/P1)^(1/n)];
14 V1=Vs+Vc;
15 W=[n/(n-1)]*[P1*100]*[V1-V4]*[((P2/P1)^((n-1)/n))
    -1];
16 R=0.287;
17 T1=15+273;
18 Md=[P1*(V1-V4)*100]/[R*T1];
19 Wpkg=W/Md;
20 printf('Work done per kg: %3.2f kJ/kg of air',Wpkg);
21 printf('\n');
22
23 T2=T1*[(P2/P1)^((n-1)/n)];
24 G=1.4;
25 Q=[(G-n)/(G-1)]*[(R*(T1-T2))/(n-1)];
26 printf('Heat Transferred: %3.2f kJ/kg',Q);
27 printf('\n');
28
29 Pm=W/Vs;
30 printf('Mean Effective Pressure: %3.2f kPa',Pm);
31 printf('\n');
32
33 Mac=V1/(V1-V4);
34 printf('Mass of air compressed to delivered: %3.2f ',
    Mac);
35 printf('\n');
36
37 Tf=T1;
38 Pf=101.325;
39 Vf=[P1*100*(V1-V4)*Tf]/[Pf*T1];
40 RPM=500;
41 Vf=Vf*RPM;
42 printf('FAD at standard condition: %3.2f m^3/min',Vf
    );
43 printf('\n');
44
45 IP=[W*RPM]/60;
46 Etrans=0.92;

```

```

47 Emech=0.85;
48 Emotor=0.75;
49 MP=IP/[Etrans*Emech*Emotor];
50 printf('Motor Power: %3.2 f kW',MP);
51 printf('\n');
52
53 MAC=Md*RPM;
54 printf('Mass of air compressed: %3.2 f kg/min',MAC);
55 printf('\n');
56
57 ACC=MAC*Mac;
58 printf('Air compressed in cylinder: %3.2 f kg/min',
        ACC);
59 printf('\n');
60
61 printf('End Temperature: %3.2 f 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: %3.4 f m^3/cycle',V4);
14 printf('\n');
15 printf('V3: %3.4 f m^3/cycle',V3);

```



```

16 printf( '\n' );
17
18 V1=Vs+Vc;
19 printf( 'V1: %3.4 f 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: %3.0 f 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: %3.1 f
    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: %3.5 f 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: %3.2 f 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: %3.2 f 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: %3.1 f 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: %3.1 f Mpm',Mpm);
18 printf('\n');
19
20 printf('Indicated Power: %3.1 f kW',IP);
21 printf('\n');
22
23 T2=T1*[(P2/P1)^((n-1)/n)];
24 printf('T2: %3.1 f 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;

```

```

9 P2=6;
10 n=1.25;
11
12 Vs=(22/7)*(1/4)*D*D*L;
13 Vc=0.05*Vs;
14 V1=Vs+Vc;
15 V4=Vc*[(P2/P1)^(1/n)];
16
17 IP=[n/(n-1)]*[P1*100*(V1-V4)]*[((P2/P1)^((n-1)/n))
    -1];
18 IPf=IP**(N/60)
19 printf('IP: %3.2 f kJ',IPf);
20 printf('\n');
21
22 Pm=IP/Vs;
23 printf('Mean Effective Pressure: %3.2 f kN/m^2',Pm);
24 printf('\n');

```

Scilab code Exa 8.19.1 Example 19

```

1 clc
2 clear
3
4 n=1.2;
5 m=5;
6 R=0.287;
7 T2=107+273;
8 T1=27+273;
9 IP=[n/(n-1)]*[m/60]*[R*(T2-T1)];
10 printf('Air Power: %3.2 f kW',IP);
11 printf('\n');
12
13 BP=14;
14 Em=IP*100/BP;
15 printf('Mechanical Efficiency: %3.0 f 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: %3.1 f kW',IP);
14 printf( '\n' );
15 printf( 'BP: %3.1 f kW',BP);
16 printf( '\n' );
17
18 IsoP=P1*100*V1*[log(P2/P1)]*(100/60);
19 Eo=IsoP/BP;
20 printf( 'Isothermal Efficiency: %3.1 f 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: %3.1 f kW',BP);
26 printf( '\n' );
27
28 Emot=0.96;
29 EMC=BP/Emot;
30 printf( 'Electric Motor Capacity: %3.1 f 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: %3.1 f kW',SP);
12 printf( '\n' );
13
14 IsoP=P1*100*V1*(log(P2/P1))*(1/60);
15 Eo=IsoP/SP;
16 printf( 'Overall Efficiency: %3.0 f Percent',Eo*100);
17 printf( '\n' );

```

Scilab code Exa 8.24.1 Example 24


```

1  clc
2  clear
3
4  V1=25;
5  P1=1;
6  P2=7;
7  N=460;
8  Em=0.8;
9  Ev=0.76;
10 Ei=0.81;
11
12 IsoP=P1*100*V1*(log(P2/P1));
13 IndP=IsoP/Ei;
14 Vs=V1/Ev;
15 Pm=IndP/Vs;
16 BP=IndP/(3600*Em);
17
18 printf('Mean Effective Pressure: %3.2f bar',Pm/100);
19 printf('\n');
20
21 printf('BP: %3.2f kW',BP);
22 printf('\n');

```

Scilab code Exa 8.25.1 Example 25

```

1  clc
2  clear
3
4  Va=3;
5  Pa=1;
6  Ta=17+273;
7  P2=8.2;
8  N=300;
9  n=1.35
10 LD=1.2;

```

```

11 Em=0.9;
12 C=0.05;
13
14 P1=Pa-0.05;
15 T1=Ta+10;
16 V14=[Pa*Va*T1]/[P1*Ta];
17
18 IP=[n/(n-1)]*[P1*100*V14/60]*[((P2/P1)^((n-1)/n))
    -1];
19 BP=IP/Em;
20 printf('BP: %3.1 f kW',BP);
21 printf('\n');
22
23 Ev=1+C-[C*((P2/P1)^(1/n))];
24 printf('Volumetric Efficiency: %3.1 f Percent',Ev
    *100);
25 printf('\n');
26
27 Vs=(22/7)*(1/4)*LD;
28 VsMin=Vs*2*N;
29 D3=V14/[VsMin*Ev];
30 D=D3^(1/3);
31 printf('Cylinder Diameter: %3.0 f mm',D*1000);
32 printf('\n');

```

Scilab code Exa 8.26.1 Example 26

```

1 clc
2 clear
3
4 V1=1;
5 P1=1.013;
6 T1=15+273;
7 P2=7;
8 R=0.287;

```

```

9  n=1.35;
10
11 m=[P1*100*V1]/[R*T1];
12 printf('Mass of air per minute: %3.1f kg',m);
13 printf('\n');
14
15 T2=T1*[((P2/P1)^((n-1)/n))];
16 printf('T2: %3.1f K',T2);
17 printf('\n');
18
19 IP=[n/(n-1)]*[P1*100*V1/60]*[((P2/P1)^((n-1)/n))-1];
20 printf('IP: %3.1f kW',IP);
21 printf('\n');
22
23 IsoP=P1*100*V1*(1/60)*log(P2/P1);
24 Ei=IsoP/IP;
25 printf('Isothermal Efficiency: %3.0f Percent',Ei
        *100);
26 printf('\n');

```

Scilab code Exa 8.27.1 Example 27

```

1  clc
2  clear
3
4  P1=1.013;
5  T1=15+273;
6  P2=7;
7  FAD=0.3;
8  G=1.4;
9
10 IP=[G/(G-1)]*[P1*100*FAD/60]*[((P2/P1)^((G-1)/G))
    -1];
11 printf('For Isentropic process \n');
12 printf('IP: %3.1f kW',IP);

```

```

13 printf( '\n' );
14
15 T2=T1*[(P2/P1)^((G-1)/G)];
16 printf( 'T2: %3.0 f 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: %3.3 f kW', IP);
22 printf( '\n' );
23
24 T2=T1;
25 printf( 'T2: %3.0 f 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: %3.3 f kW', IP);
32 printf( '\n' );
33
34 T2=T1*[(P2/P1)^((n-1)/n)];
35 printf( 'T2: %3.2 f 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

```
1  clc
2  clear
3
4  m=1;
5  P1=1;
6  P2=5;
7  T1=27+273;
8  n=1.25;
9  R=0.287;
10
11 W=m*R*T1*log(P2/P1);
12 printf('Work Done for Isothermal Process: %3.2f kJ/
      kg \n\n',W);
13 printf('\n');
14
15 G=1.4;
16 W=[G/(G-1)]*[m*R*T1]*[((P2/P1)^((G-1)/G))-1];
17 printf('Work Done for Isentropic Process: %3.2f kJ/
      kg \n\n',W);
18 printf('\n');
19
20 W=[n/(n-1)]*[m*R*T1]*[((P2/P1)^((n-1)/n))-1];
21 printf('Work Done for Polytropic Process: %3.2f kJ/
      kg \n\n',W);
22 printf('\n');
```

Scilab code Exa 8.31.1 Example 31

```
1  clc
2  clear
3
4  D=0.15;
5  L=0.3;
```

```

6 P1=1;
7 T1=27+273;
8 P2=8;
9 N=120;
10 G=1.4;
11 R=0.287;
12 Vs=(22/7)*(1/4)*D*D*L;
13
14 m=[P1*100*Vs]/[R*T1];
15 printf('Mass of air compressed per cycle: %3.4f kJ/
    cycle ',m);
16 printf('\n');
17
18 W=[G/(G-1)]*[P1*100*Vs]*[(((P2/P1)^((G-1)/G))-1)];
19 printf('Work required per cycle: %3.3f kJ/cycle ',W)
    ;
20 printf('\n');
21
22 P=(W*N)/60;
23 printf('Power required to drive compressor: %3.2f kJ
    /cycle ',P);
24 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: %2.2 f 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: %2.2 f Percent',Slip*100);
27 printf('\n');
28
29 Cd=Qa/Q;
30
31 P=(Rho*g*Qa*(Hs+Hd))/Ep;
32 printf('Power input: %2.2 f 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: %2.2 f RPM',N);
16 printf('\n');

```

Scilab code Exa 9.3.1 Example 3

```

1  clc
2  clear
3
4  Hs=32;
5  N=1450;
6  Eff=0.85;
7  Q=0.05;
8  Hfs=1;
9  Hfd=6;
10 Hm=Hs+Hfd+Hfs;
11 Rho=1000;
12 g=9.81;
13
14 P=[Rho*g*Q*Hm]/Eff;
15 printf('Power Consumed: %2.2 f kW',P/1000);
16 printf('\\n');

```

Scilab code Exa 9.4.1 Example 4

```

1  clc
2  clear
3
4  Pm=25;
5  Em=0.9;
6  Q=0.063;
7  Hs=4;
8  Hd=25;
9  Rho=1000;
10 Hm=Hs+Hd;
11 g=9.81;
12
13 Ph=Rho*g*Q*Hm/1000;
14 Ps=Em*Pm;
15 Ep=Ph/Ps;
16

```

```
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: %2.2 f 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= %2.2 f',VR);
12 printf('\n');
13 printf('Speed of driven shaft= %2.2 f 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= %2.2 f',VR);
20 printf('\n');
21 printf('Speed of driven shaft= %2.2 f 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= %2.2 f',VR);
29 printf('\n');
30 printf('Speed of driven shaft= %2.2 f RPM',N2);
31 printf('\n\n');

```

Scilab code Exa 13.3.1 Example 3

```

1 clc
2 clear
3
4 D1=0.3;

```

```

5 D2=0.2;
6 C=3;
7
8 L1=[(22/7)*(1/2)*(D1+D2)]+[((D1+D2)^2)/(4*C)]+(2*C);
9 L2=[(22/7)*(1/2)*(D1+D2)]+[((D1-D2)^2)/(4*C)]+(2*C);
10
11 L=L2-L1;
12 printf('The belt length is to be reduced by %2.4f mm
        ',(0-L)*1000);
13 printf('\n');

```

Scilab code Exa 13.4.1 Example 4

```

1 clc
2 clear
3
4 D=1;
5 P=5000;
6 N=250;
7 Mew=0.25;
8 PP=20;
9 Theta=170*(22/7)*(1/180);
10 V=((22/7)*D*N)/60;
11
12 T12=exp(Mew*Theta)-1;
13 T2=(P/(V*T12));
14 T1=(T12+1)*T2;
15 W=T1/PP;
16
17 printf('Width of belt= %2.2f mm',W);
18 printf('\n');

```

Scilab code Exa 13.5.1 Example 5

```

1  clc
2  clear
3
4  N1=1000;
5  Z1=30;
6  Z2=45;
7  Z3=75;
8
9  N13=Z3/Z1;
10 N3=N1/N13;
11
12 printf('Velocity Ratio of gear train= %2.1f ',N13);
13 printf(' \n ');
14 printf('N3= %2.1f RPM',N3);
15 printf(' \n ');

```

Scilab code Exa 13.6.1 Example 6

```

1  clc
2  clear
3
4  Na=600;
5  Za=25;
6  Zb=50;
7  Zc=20;
8  Zd=40;
9  Nad=(Zb/Za)*(Zd/Zc);
10 Nd=Na/Nad;
11
12 printf('Speed of Output Shaft= %2.1f RPM',Nd);
13 printf(' \n ');

```
