Scilab Textbook Companion for Basic Mechanical Engineering by Basant Agarwal & C.M.Agarwal[1]

Created by
Reshma Dastageer Ustad
BE
Electronics Engineering
AIKTC
College Teacher
None
Cross-Checked by
None

July 31, 2019

[1]Funded by a grant from the National Mission on Education through ICT, http://spoken-tutorial.org/NMEICT-Intro. This Textbook Companion and Scilab codes written in it can be downloaded from the "Textbook Companion Project" section at the website http://scilab.in

Book Description

Title: Basic Mechanical Engineering

Author: Basant Agarwal & C.M.Agarwal

Publisher: Wiley India Pvt.Ltd, New Delhi

Edition: 1

Year: 2008

ISBN: 978-81-265-1878-4

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

Contents

List of Scilab Codes

Chapter 2

Properties Of Material

Scilab code Exa 2.1 `Cross Section Area of bar`

```
///Example 1.2 Page No:20
///Find Cross−Section Area
///Input data
clc;
clear;
L1=5;                          //Length of steel bar in m
d1=25*10^-3;                   //Diametr of steel bar in mm
deltaLt1=25*10^-3;             ///Steel
pt1=800;
pi1=3.142;                     //Power load of steel bar in N

////Calculation
A1=(pi1/4)*((deltaLt1)^2); ///Cross−section area
sigmat1=pt1/A1;             //Stress in  steel bar
et1=deltaLt1/L1;              ///Strain in steel bar
E1=sigmat1/et1;           //Young's modulus

///Output
```

```
mprintf('value of Cross-section area= %f  \n',A1);
printf('value of stress in  steel bar= %f MN/m^2 \n',sigmat1);
printf('value of strain in steel bar= %f \n',et1);
printf('value of Youngs modulus= %f N/m^2 \n',E1);
```

Scilab code Exa 2.2 Stress in Steel bar

```
///Example 1.2 Page No:20
///Find Stress in Steel bar
///Input data
clc;
clear;
L1=300*10^-3;          //Length of hexagonal prismatic steel bar in mm
A1=500*10^-6;          //Area of cross section of steel bar mm**2
Pt1=500*10^3;          //Load of steel bar in KN
E1=210*10^9;           //Modulus of elasticity GN/m**2

///Calculation
sigmat1=Pt1/A1;    //Stress in steel bar
et1=sigmat1/E1;    //Strain steel bar is
deltaLt1=et1*L1;   //Therefore,elongation of the steel bar is given by

////Output
printf('stress in steel bar= %f  N/m^2 \n',sigmat1);
printf('therefore,strain steel bar is given by= %f \n',et1);
printf('therefore,elongation of the steel bar is given by= %f m',deltaLt1);
```

Scilab code Exa 2.3 `Stress in the Steel wire`

```
///Example 1.3 Page No:21
///Find Stress in the Steel wire
//Input Data
clc;
clear;
Pt1=600;                        //Tensils force in N
d1=2*10^-3;                     //Diameter of steel wire in mm
L1=15;                          //Length of wire in m
E1=210*10^9;                    //Modulus of elasticity of the material in GN/M**2
pi1=3.1482;


//Calculation
A1=(pi1/4)*(d1^2);        //(1)cross section area
sigmat1=(Pt1)/(A1);             //stress in the steel wire
et1=((sigmat1)/(E1));           //(2)Therefore, strain in steel wire is given by
deltaLt1=et1*L1;                //(3)Enlongation of the steel wire is given by
pe=((deltaLt1/L1)*100);      //(4)Percentage elongation


/////Output
printf('cross section area= %f m^2\n',A1);
printf('stress in the steel wire= %f GN/m^2 \n',sigmat1);
printf('modulus of elasticity=%f \n',et1);
printf('strain in steel wire=%f  mm \n',deltaLt1)
printf('percentage elongation=%f percent \n',pe)
```

Scilab code Exa 2.4 Stress in square rod

```
////Example 1.4 Page No:22
///Find Stress in square rod
//Input data
clc;
clear;
A1=30*30*10^-6;        //Area of square rod in mm**2
L1=5;                   ///Length of square rod in m
Pc=150*10^3;          //Axial comperessive load of a
   rod  in kN
E1=215*10^9;            //Modulus of elasticity in GN/m
   **2


//Calculation
sigmac=((Pc)/(A1));    //Stress in square rod
ec=(sigmac)/(E1);    //Modulusof elasticity is E1=
   sigmac/ec ,therefore strain in square rod is
deltaLc=ec*5;          ///Therefore shortening of
   length of the rod


///Output
printf('stress in square rod %f N/m^2',sigmac);
printf('\n');
printf('strain in square rod ec= %f\n',ec);
printf('shortening of length of the rod= %f m \n',
   deltaLc);
```

Scilab code Exa 2.5 Stress in metallic rod

```
////Example 1.5 Page No:23
////Find Stress in metallic rod
////input data
clc;
clear;
d1=50*10^-3;                    //Diameter of metalic rod in mm**2
L1=220*10^-3;                   //Length of metalic rod in mm
Pt1=40*10^3;                    //Load of metalic rod in KN
deltaLt1=0.03*10^-3;            //Elastic enlongation in mm
ypl=160*10^3;                  //Yield point load in KN
ml=250*10^3;                   //Maximum load in KN
lsf=270*10^-3;                 //Length of specimen at fracture in mm
pi=3.142;

//calculation
A1=(((pi)/(4))*((d1)^2));       //(1)Cross section area
sigmat1=Pt1/A1;                  //Stress in metallic rod
et1=deltaLt1/L1;                 //Strain n metallic rod
E1=sigmat1/et1;                  //Young's modulus
ys=ypl/A1;                     //(2)Yeild strength
uts=ml/A1;                     //(3)Ultimate tensile strength
Pebf1=((lsf-L1)/L1)*100;           //Percentage elongation before fracture

//output
printf('cross section area = %f m^2\n',A1);
printf('stress in metallic rod= %f N/m^2 \n',sigmat1);
printf('strain n metallic rod= %f \n',et1);
printf('youngs modulus= %f GN/m^2\n',E1);
printf('yeild strength= %f MN/m^2\n',ys);
```

```
printf('ultimate tensile strength= %f MN/m^2 \n',uts
    );
printf('percentage elongation before fracture= %f
    percent \n ',Pebf1);
```

Scilab code Exa 2.6 Stress in square metal bar

```
////Example 1.6 Page No:24
///Find Stress in square metal bar
//Input data
clc;
clear;
A1=50*50*10^-6;                         //Area ofsquare
    metal bar in mm**2
Pc=600*10^3;                           //Axial compress laod
     in KN
L1=200*10^-3;                           //Gauge length of
    metal bar in mm
deltaLc=0.4*10^-3;                     //Contraction length
    of metal bar in mm
deltaLlateral=0.05*10^-3;              //Lateral length of
    metal bar in mm

//Calculation
sigmac=Pc/A1;                  //Stress in square metal
    bar
ec=deltaLc/L1;                 //Longitudinal or linear
    strain in square metal bar
E1 =sigmac/ec;                 //Smodule of elasticity
elateral=deltaLlateral/L1; //Lateral strain in
    square metal bar
poissonsratio=elateral/ec;


//Output
```

```
printf('stress in bar=%f N/m^2 \n',sigmac);
printf('longitudinal or linear strain in square
   metal bar= %f \n',ec);
printf('module of elasticity= %f N/m^2 \n',E1);
printf('lateral strain in square metal bar=%f \n',
   elateral);
printf('poissons ratio=%f \n',poissonsratio);
```

Chapter 5

Metrology

Scilab code Exa 5.1 The Diameter of the rod

```
//Example 5.1 Page No:81
//Find Diameter of the rod
//Input data
clc;
clear;
MSR=3.2;            //Main scale reading of
   cylindrical rod in cm
NCD=7;              //Number of coinciding Vernier
   Scale division
Lc=0.1*10^-3;     //Least count of the instrument in
   mm

//Calculation
DOR=MSR+(NCD*Lc); //Diameter of the rod

//Output
printf('Diameter of the rod= %f cm \n',DOR);
```

Scilab code Exa 5.2 Measured length of bar

```
///Example 5.2 Page No:82
///Measured length of bar
//Input data
clc;
clear;
MSR=5.3;                  //Main scale reading of prismatic bar in cm
NCD=6;                    //Number of coinciding Vernier Scale division
Lc=0.1*10^-3;            //Least count of the instrument in mm
Ne=(-0.2*10^-3);         //Instrument bears a nagative error in mm

//Calulation
Mlb=MSR+(NCD*Lc);        //Measured length of the bar in cm
Tlb=(Mlb-(Ne));          //True length of the bar in cm


//Output
printf('Measured length of the bar= %f cm \n ',Mlb);
printf('True length of the bar= %f cm ",Tlb);
```

Scilab code Exa 5.3 Height required to setup of bar

```
///Example 5.3 Page No:88
///Find Height required to setup of bar
//Input data
clc;
clear;
//Import maths
L=100;              //Height of sine bar
theta=12.8        //angle in degree minut
//Z=sin(theta)=0.22154849
```

```
Z=0.22154849

///Calculation
b=Z*L;          //Height required to setup in mm


///Output
printf('Height required= %f mm \n',b);
```

Chapter 7

Fluid Mechanics

Scilab code Exa 7.1 `mass density of liquid`

```
///Chapter No 7 Fluid Mechanics
///Example 7.1 Page No:113
////Find mass density of liquid
//Input data
clc;
clear;
V=5;              //volume of the liquid in m**3
W=45*10^3;       //weight of the liquid in KN
g=9.81;           //acceleration due to gravity in m/s
   **2
rhow=1000;        //constant value

////Calculation
m=W/g;     //mass in Kg
rho=m/V;        //Mass density in kg/m**3
w=W/V;          //Weight Density in N/m**3
v=V/m;          //Specific volume in m**3/kg
S=rho/rhow;       //Specific gravity


//Output
```

```
printf('mass=%f kg \n',m);
printf('Mass density= %f kg/m^3 \n  ',rho);
printf('Weight Density= %f N/m^3\n ',w);
printf('Specific volume=%f m^3/kg \n',v);
printf('Specific gravity= %f \n',S);
```

Scilab code Exa 7.2 `mass density of oil`

```
///Chapter No 7 Fluid Mechanics
////Find mass density of oil
///Example 7.2 Page No:114
///Input data
clc;
clear;
V=3*10^-3;          //3l of oil in m**3
W=24;                //Weight of oil in N
g=9.81;              //Gravity in m/s**2
rhow=1000;           //Constant value


//Calculation
m=W/g;       //Mass in Kg
rho=m/V;          //Mass density in kg/m**3
w=W/V;            //Weight Density in N/m**3
v=V/m;            //Specific volume in m**3/kg
S=rho/rhow;         //Specific gravity

//Output
printf('mass= %f kg \n',m);
printf('Mass density= %f kg/m^3 \n',rho);
printf('Weight Density= %f N/m^3\n ',w);
printf('Specific volume= %f m^3/kg \n ',v);
printf('Specific gravity= %f \n ',S);
```

Scilab code Exa 7.3 `mass density of liquid`

```
///Chapter No 7 Fluid Mechanics
////find mass density of liquid
///Example 7.3 Page No:114
//Input data
clc;
clear;
S=0.85;                    //Specific gravity of a liquid
g=9.81;                    //Acceleration due to gravity in
    m/s**2(constant)
rhow=1000;                 //Constant value


///Calculation
//Specific gravity S=roh/rohw
rho=S*rhow;                //Mass density in Kg/m**3
w=rho*g;                   //Weight Density in N/m**3
v=1/rhow;                 //Specific volume in m**3/kg


///Output
printf('Mass densit= %f kg/m^3 \n  ',rho);
printf('Weight Density=%f N/m^3 \n ',w);
printf('Specific volume= %f m^3/kg \n ',v);
```

Scilab code Exa 7.4 `mass density of liquid`

```
///Chapter No 7 Fluid Mechanics
///Example 7.4 Page No:116
////Find mass density of liquid
//Input data
```

```
clc;
clear;
dy=21*10^-3;        //Horizontal plates in mm
du=1.4;             //Relative velocity between the plates in m/s
mu=0.6;             //Oil of viscosity 6 poise in Ns/m^2

///Calculation
tau=mu*(du/dy);  //Shear in the oil in N/m^2

///Output
printf('shear in the oil= %f N/m^2 \n',tau);
```

Scilab code Exa 7.5 `mass density of liquid`

```
///Chapter No 7 Fluid Mechanics
///Find viscosity of the liquid
///Example 7.5 Page No:116
//Input data
clc;
clear;
v=4*10^-4;     ///kinematic viscosity is 4 stoke inm**2/s
S=1.2;         //specific gravity
dow=1000;      ///density of water Kg/m**3


///Calculation
rho=S*dow;
vol=rho*v;     //viscosity of the liquid in Ns/m**2 or poise

///Output
printf('viscosity of the liquid= %f Ns/m^2 \n',vol);
```

Scilab code Exa 7.6 `newtons law of viscosity in shear stress`

```
///Chapter No 7 Fluid Mechanics
//// Find newton's law of viscosity in shear stress
///Example 7.6 Page No:116
///Input data
clc;
clear;
S=0.9;              //Specific gravity
tau=2.4;            //shear stress in N/m**2
vg=0.125;       //velocitty gradientin per s
dow=1000;           //density of water Kg/m**3


///Calculation
mu=tau/vg;   //newton's law of viscosity in shear
    stress in Ns/m**2
rho=S*dow;          //Density of oil in Kg/m**3
v=mu/rho;       //Kinematic viscosity in m**2/s or
    stoke

///Output
printf('newtons law of viscosity in shear stress= %f
     Ns/m^2 \n',mu);
printf('Density of oil= %f kg/m^3 \n  ',rho);
printf('Kinematic viscosity=%f m^2/s \n ',v);
```

Scilab code Exa 7.7 `Density of oil`

```
///Chapter No 7 Fluid Mechanics
////Example 7.7 Page No:117
```

```
///Find  Density of oil
///Input data
clc;
clear;
A=6*10^-2;              //Space between two square
    plates in mm
dy=8*10^-3;             //Thickness of fluid in mm
u1=0;                    //Lower pate is stationary
u2=2.4;                  //Upper plate in m/s
F=5;                     //Speed of force in N
s=1.6;                   //Specific gravity of the
    liquid
dow=1000;                //Density of water Kg/m**3


//(1)Calculation
du=u2-u1;                //change in velocity in m/s
tau=F/((A)^2);       //shear stress N/m**2
mu=tau/(du/dy);       //Newton's law of viscosity in
    Ns/m**2 or poise
rho=s*dow;               //Density of oil in kg/m**3
v=mu/rho;             ///kinematic viscosity is given
    by m**2/s or stoke


///Output
printf('change in velocity=%f m/s \n ',du);
printf('shear stress=%f N/m^2 \n  ',tau);
printf('Newtons law of viscosity=%f Ns/m^2 \n',mu);
printf('Density of oil=%f kg/m^3 \n ',rho);
printf('kinematic viscosity=%f m^2/s ',v);
```

Scilab code Exa 7.8 Power required to maintain the speed of upper plate

```
///Chapter No 7 Fluid Mechanics
```

```
////Example 7.8 Page No:118
/// Find Power required to maintain the speed of
   upper plate
//Input data
clc;
clear;
dy=1.5*10^-4;        //Two horizontal plates are
   placed in m
mu=0.12;              //Space between plates  Ns/m**2
A=2.5;                //Upper area is required to move
    in m**2
du=0.6;               //Speed rerlated to lower plate
   in m/s


////(1)Calculation
tau=mu*(du/dy);    //Shear stress N/m**2
F=tau*A;              //Force in N
P=F*du;               //Power required to maintain the
    speed of upper plate in W


//Output
printf('Shear stress=%f N/m^2 \n ',tau);
printf('Force=%f N \n ',F);
printf('Power required to maintain the speed of
   upper plate=%f W \n ',P);
```

Scilab code Exa 7.9 Tangential speed of shaft

```
///Chapter No 7 Fluid Mechanics
///Example 7.9 Page No 118
///Find Tangential speed of shaft
//Input data
clc;
```

```
clear;
mu=0.1;                        //Oil of viscosity used for
    lubricant in poise or Ns/m**2
D=0.15;                        //Clearance between the
    shaft of diameter in m
dy=3*10^-4;                   //Clearance in m
N=90;                          //Shaft rorates in rpm
pi=3.14;


///Calculation
du=(pi*D*N)/60;          //Tangential speed of shaft in
     m/s
tau=mu*(du/dy);          //The shear force in N/m**2

///Output
printf('Tangential speed of shaft=%f m/s \n ',du);
printf('The shear force= %f  N/m^2 \n ',tau);
```

Scilab code Exa 7.10 Kinematic viscosity

```
///Chapter No 7 Fluid Mechanics
///Example 7.10 Page No:119
/// Find Kinematic viscosity
//Input data
clc;
clear;
//import math
A=120*10^-3;           //Side of square plate in mm
W=30;                    //Side weight in N
du=3.75;                 //Uniform velocity in m/s
theta=30;                //Lubricated inclined plane
    making an angle in degree at horizontal
dy=6*10^-3;            //Thickness lubricating oil film
     in mm
```

```
rho=800;                //Lubricating oil film density in Kg/m**3


//Calculation
sin30=0.5;
F=W*sin30;              //Component of force in N
tau=(F/(A**2));         //Shear stress in Ns/m**2
mu=tau/(du/dy);       //From Newton's law of Shear stress in Ns/m**2
V=(mu/rho)*10^3;        //Kinematic viscosity in m**2/s


///Output
printf('Component of force=%f N \n ',F);
printf('Shear stress=%f Ns/m^2 \n ',tau);
printf('From Newtons law of Shear stress=%f Ns/m^2 \n  ',mu);
printf('Kinematic viscosity= %f m^2/s \n ',V);
```

Scilab code Exa 7.11 `Density of oil`

```
///Chapter No 7 Fluid Mechanics
//Example 7.11 Page No 121
//#Input data
clc;
clear;
Z=15;                 //Pressure due to column in m
S=0.85;               //Oil of specific gravity
g=9.81;               //Gravity



///Calculation
rho=S*10^3;         //Density of oil in kg/m**3
```

```
P=rho*g*Z;          //Pressure in N/m**2 or kPa


///Output
printf('Density of oil= % f kg/m^3 \n ',rho);
printf('Pressure= %f N/m**2 \n ',P);
```

Scilab code Exa 7.12 Intensity of pressure of water

```
///Chapter No 7 Fluid Mechanics
///Example 7.12 Page No 122
/// Find Intensity of pressure of water
///Input data
clc;
clear;
Z1=1.5;                        //open tank contain water
    in m
Z2=2.5;                        //oil of specific gravity
    for depth in m
S=0.9;                         //oil of specific gravity
rho1=1000;                     //density of water in Kg/m
    **3
rho2=S*10^3;                  //density of oil in Kg/m**3
g=9.81;                        //gravity



///calculation
P=rho1*g*Z1+rho2*g*Z2;         //Intensity of pressure in
     kPa


///output
printf('intensity of pressure=%f N/m^2 \n',P);
```

Scilab code Exa 7.13 `Discharge through pipe`

```
///Chapter No 7 Fluid Mechanics
///Example 7.13 Page No:124
///Find Discharge through pipe
///Input data
clc;
clear;
D1=0.2;                          //Diameter of pipe section 1 in m
D2=0.3;                          //Diameter of pipe section 2 in m
V1=15;                           //Velocity of water in m/s
pi=3.14;

///calculation
Q=((3.14/4)*(0.2)^2)*15;     //Discharge through pipe in m**3/s
V2=(((3.14/4)*(0.2)^2)*15)/((3.14/4)*(0.3)^2); //velocity of section2 in m/s


///Output
printf('Discharge through pipe= %f m^3/s \n ',Q);
printf('velocity of section2= %f m/s \n ',V2);
```

Scilab code Exa 7.14 `Total energy per unit weight`

```
///Chapter No 7 Fluid Mechanics
////Example 7.14 Page No:126
////Find Total energy per unit weight
```

```
//Input data
clc;
clear;
V=13;                    //Velocity of water flowing
    throgh pipe in m/s
P=200*10^3;             //Pressure of water in Kpa
Z=25;                    //Height above the datum in m
g=9.81;
rho=1000;


///Calculation
E=(P/(rho*g))+((V^2)/(2*g))+(Z); //Total energy per
    unit weight in m


///Output
printf('Total energy per unit weight= %f m \n',E);
```

Scilab code Exa 7.15 `Total energy per unit weight`

```
///Chapter No 7 Fluid Mechanics
///Example 7.15 Page No:127
/// Find Total energy per unit weight
///Input data
clc;
clear;
S=0.85;                  //Specific gravity of oil
D=0.08;                  //Diameter of pipe in m
P=1*10^5;               //Intenity of presssure in N/m^2
Z=15;                    //Total energy bead in m
E=45;                    //Datum plane in m
Mdw=1*10^3;             //Mass density of water constant
g1=9.81;                  //Gravity constant
rho=S*Mdw;               //Mass density of oil
```

```
pi1=3.14;

///calculation
rho=S*Mdw;              //Mass density of oil
//E=(P/(rho*g1))+((V**2)/(2*g1))+(Z);
V=sqrt((E-((P/(rho*g1))+Z))*(2*g1));  ///Total energy per unit weight in m/s
Q1=(pi1/4)*D^2*V                                //Discharge in m^3/Kg

///output
printf('mass density of oil=%f Kg/m^3 \n',rho);
printf('Total energy per unit weight= %f m/s \n ',V);
printf('discharge= %f m^3/kg',Q1);
```

Scilab code Exa 7.16 Continuity Discharge Equation

```
///Chapter No 7 Fluid Mechanics
///Example 7.16 Page No:127
///Find continuity discharge equation
///input data
clc;
clear;
///refer figure 11
ZA=2;                    //water flows section A–A in m
DA=0.3;                  //datum pipe diameter at section A–A in m
PA=550*10^3;            //pressure in kPa
VA=6;                    //flow velocity in m/s
ZB=18;                   //water flows at section B–B in m
DB=0.15;                 //datum pipe diameter at section B–B in m
```

```
pi1=3.14;                    //constant
rho=1000;                   //constant
g1=9.81;                     //constant
Aa=(pi1/4)*(DA)^2;
Ab=(pi1/4)*(DB)^2;
pi1=3.14;

///calculation
VB=((Aa*VA)/Ab);             //continuity discharge
   equation in m/s
//bernoulli's equation Kpa
//(PA/rho*g)+(VA**2/2*g)+ZA=(PB/rho*g)+(VB**2/2*g)+
   ZB
PB=(((PA/(rho*g1))+(VA**2/(2*g1))+ZA)-((VB**2/(2*g1)
   )+ZB))*(rho*g1);


///output
printf('continuity discharge equation= %f m/s \n',VB
   );
printf('bernoullis equation= %f pa \n ',PB);
```

Scilab code Exa 7.17 Bernoullis equation for discharge

```
///Chapter No 7 Fluid Mechanics
///Example 7.17 Page No:128
/// Find bernoulli's equation for discharge
//input data
//refer figure 12
clc;
clear;
Q1=0.04;                //Water flows at rate in m**2/s
DA=0.22;              //Pipe diameter at section A in
   m
DB=0.12;              //Pipe diameter at section B in
```

```
   m
PA=400*10^3;        //Intensity of pressure at setion A in kPa
PB=150*10^3;        //Intensity of pressure at setion B in kPa
pi1=3.14;             //Pi constant
g1=9.81;              //Gravity constant
rho=1000;

///Calculation
VA=Q1/(pi1/4*(DA)^2); //contuity equation for discharge
VB=Q1/(pi1/4*(DB)^2); //bernoulli's equation for discharge
///Z=ZB-ZA
Z=(PA/(rho*g1))+(VA^2/(2*g1))-(PB/(rho*g1))-(VB^2/(2*g1));


///Output
printf('Contuity equation for discharge= %f m63 \n ',VA);
printf('Contuity equation for discharge= %f m^3 \n ',VB);
printf('Bernoullis equation for discharge=%f m \n',Z);
```

Scilab code Exa 7.18 `Rate of water flow`

```
///Chapter No 7 Fluid Mechanics
///Example 18 Page No:129
//// Find rate of water flow l/min
//Input data
clc;
clear;
```

```
L1=200;                   //length of pipe in m
D11=1;                    //Diameter at high end in m
D12=0.4;                  //Diameter at low end in m
P1=50*10^3;             //Pressure at high end  in kPa
Q1=4000;                  //Rate of water flow l/min
S=1;                     //Slope of pipe 1 in 100
Z2=0;                    //Datum line is passing through the center of the low end,therefore
pi1=3.14;
rho=1000;
g1=9.81;


///Calculation
Q1=(4000*10^-3)/60;    //rate of water flow l/min in m**3/s
Z1=1/100*L1;             //slope of pipe 1 in 100 is in m
//Q=A1*V11=A2V2          //continuity eqation , discharge
V11=Q1/((pi1/4)*(D11^2));//in m^3
V12=Q1/((pi1/4)*(D12**2));//in m^3
//bernoulli's equation
P2=(((((P1/(rho*g1))+(V11^2/(2*g1))+Z1)-(V12^2/(2*g1))-Z2))*(rho*g1))*10^-3;


///Output
printf('rate of water flow=%f m^3/s \n ',Q1);
printf('slope of pipe=%f m \n',Z1);
printf('continuity eqation ,discharge= %f m^3 \n ",V11);
printf('continuity eqation ,discharge= %f m^3 \n ",V12);
printf('bernoullis equation for discharge= %f kpa \n',P2);
```

Scilab code Exa 7.19 `pipe inclined 30 degree therefore Z2`

```
///Chapter No 7 Fluid Mechanics
///Example 7.19 Page No:130
///Find pipe inclined 30 degree,therefore Z2
///Input data
clc;
clear;
L1=36;                      //Length of pipe in m
D11=0.15;                   //Diameter at upper side in m
D12=0.3;                    //Diameter at lower side in m
sin30=0.5;
theta=sin(30);       //Pipe slope upward at angle in degree
V11=2;                      //Velocity of water at smaller section in m/s
pi1=3.14;                   //Pi constant
rho=1000;                  //Roh constant
g1=9.81;                    //Gravity constant


///Calculation
//datum line is passing through the center of the low end,therefore
Z1=0;
Z2=Z1+L1*(0.5);             //pipe inclined 30 degree, therefore in m
//Q=A1*V1=A2*V2  continuity eqation ,discharge
V12=(pi1/4*(D11^2)*2)/(pi1/4*(D12^2));
//Z=P1-P2 bernoulli's equation
Z=((((-V11^2)/(2*g1))+((V12^2)/(2*g1))-Z1+Z2)*(rho*g1))*10^-3;
```

```



///Output
printf('pipe inclined 30 degree,therefore Z2= %f m \n',Z2);
printf('continuity eqation discharge V2= %f m/s \n',V12);
printf('bernoullis equation Z=%f kpa \n',Z);
```

Scilab code Exa 7.20 Continuity eqation

```
///Chapter No 7 Fluid Mechanics
///Example 7.20 Page No:130-131
/// Find Continuity eqation
//Input data
clc;
clear;
D11=0.25;                          //Diameter at inlet in m
D12=0.175;                         //Diameter at outlet in m
P1=450*10^3;                      //Intensity of pressure at inlet in kPa
P2=200*10^3;                      //Intensity of pressure at outlet in kPa
pi1=3.14;                          //pi constant
rho=1000;                         //Rho constant
g1=9.81;                           //Gravity constant
//Z1=Z2;

///Calculation
///A1*V11=A2*V12                      Continuity eqation in V1
V12=((pi1/4)*(D11^2))/((pi1/4)*(D12^2));
///Z=V12^2-V11^2                    Bernoulli's equation in
```

```
m/s
Z=-(((P2/(rho*g1))-(P1/(rho*g1)))*(2*g1));
X=Z/((V12^2)-1);
V11=sqrt(X);
Q1=(pi1/4)*(D11^2)*V11;          //Flow rate Water in
  m**3/Kg


///Output
printf('Continuity eqation=%f V1 \n ",V12);
printf('Bernoullis equation=%f m/s \n  ",Z);
printf('V1= %f \n',V11);
printf('Flow rate Water= %f m^3/kg \n  ',Q1);
```

Scilab code Exa 7.21 Bernoullis equation for discharge

```
///Chapter No 7 Fluid Mechanics
///Example 7.21 Page No:131-132
///Find Bernoulli's equation
///Input data
clc;
clear;
L1=300;                     //Length of pipe in m
D11=0.9;                    //Diameter at higher end in
  m
D12=0.6;                    //Diameter at lower end in
  m
S=0.85;                    //Specific gravity
Q1=0.08;                    //Flow in l/s
P1=40*10^3;               //Pressure at higher end in
  kPa
pi1=3.14;                   //pi constant
rho=1000;                  //Rho constant
g1=9.81;                    //Gravity constant
slop=1/50;                 //1 in 50
```

```


//Calculation
//Datum line is passing through the center of the low end,therefore
Z2=0;
Z1=slop*L1;
//Q=A1*V1=A2*V2          Continuity eqation
V11=Q1/((pi1/4)*(D11^2)); //Frome continuity eqation, discharge
V12=Q1/((pi1/4)*(D12^2));      //Frome continuity eqation, discharge
///Bernoulli's equation
P2=(((((P1/(rho*S*g1))+(V11^2/(2*g1))+Z1)-(V12^2/(2*g1))+Z2))*(S*rho*g1))*10^-3;


///Output
printf('Z1= %f m \n ',Z1);
printf('continuity eqation discharge V11= %f m^3 \n ',V11);
printf('continuity eqation, discharge V12= %f m^3 \n ',V12);
printf('bernoullis equation= %f Kpa \n ',P2);
```

Chapter 9

Law Of Thermodynamics

Scilab code Exa 9.1 `Work interaction during the 4th processes`

```
///Chapter 9 Law Of Thermodynamics
///Example 9.1 Page No:165
/// Find Work interaction during the 4th processes
///Input data
clc;
clear;
Qab=720;     //Heat transfer of 1st processes in KJ
Qbc=-80;     //Heat transfer of 2nd processes in KJ
Qcd=40;      //Heat transfer of 3rd processes in KJ
Qda=-640;    //Heat transfer of 4th processes in KJ
Wab=-90;     //Work transfer of 1st processes in KJ
Wbc=-50;     //Work transfer of 2nd processes in KJ
Wcd=130;     //Work transfer of 3rd processes in KJ


///Calculation
///From the 1st law of thermodynamic for close
    system undergoing a cycle.

//Work interaction during the 4th processes
Wda=((Qab+Qbc+Qcd+Qda)-(Wab+Wbc+Wcd));
```

```
///Output
printf('Work interaction during the 4th processes=
    %f KJ \n",Wda);
```

Scilab code Exa 9.2 Quantity of heat transferred

```
///Chapter 9 Law Of Thermodynamics
///Example 9.2 Page No:166
///Find Quantity of heat transferred
///Input data
clc;
clear;
                              //During compression
W1=-9200;                      //Stroke work done by the
    piston in Nm
Nm1=-9.2;                      //Nm of work done
Q1=-50;                        //Heat rejected during
    copression in KJ
                              //During expansion
W2=8400;                       //Stroke work done by the
    piston in Nm
Nm2=8.4;                       //Nm of work done

///Calculation;
                              //Quantity of heat transferred
Q2=-((Nm1+Nm2)+Q1);            //-sign for indicate heat is
    transferred


///Output
printf('Quantity of heat transferred= %f KJ \n',Q2);
```

Scilab code Exa 9.3 Magnitude and direction of the third heat interation

```
///Chapter 9 Law Of Thermodynamics
///Example 9.3 Page No:166
/// Find Magnitude and direction of the third heat interation
///input data
clc;
clear;
W1=-20;                       //Work interaction to the fluid in KJ
W2=42;                        //Work interaction from the fluid in KJ
Q1=85;                        //Heat interaction to the fluid in KJ
Q2=85;                        //Heat interaction to the fluid in KJ
Q3=-50;                       //Heat interaction from the fluid in KJ

///Calculation
W3=((Q1+Q2+Q3)-(W1+W2)); //Magnitude and direction of the third heat interation


///Output
printf('Magnitude and direction of the third heat interation=%f KJ \n',W3);
```

Scilab code Exa 9.4 Work done and compression process of heat

```
///Chapter 9 Law Of Thermodynamics
///Example 9.4 Page No:168
/// Find Work done and compression process of heat
///Input data
```

```
clc;
clear;
Q1=-2100;          //Non flow process losses heat in KJ
deltaU=420;       //Gain heat

///Calculation
W=Q1-deltaU;       //Work done and compression process in KJ

///Output
printf('Work done and compression process= %f KJ \n',W);
```

Scilab code Exa 9.5 `Change in interval energy`

```
///Chapter 9 Law Of Thermodynamics
//Example 9.5 Page No:168
/// Find Change in interval energy
///Input data
clc;
clear;
W=-2000;       //Work input of panddle wheel in KJ
Q1=-6000;      //Heat transferred to the surrounding from tank

//Calculation
deltaU=Q1-W;    //Change in interval energy

///Output
printf('change in interval energy drop= %f  KJ \n',deltaU);
```

Scilab code Exa 9.6 `Heat transferred during the process`

```
///Chapter 9 Law Of Thermodynamics
///Example 9.6 Page No:169
/// Find Heat transferred during the process
///Input data
clc;
clear;
U1=520;         //internal energy in KJ/Kg
U2=350;         //internal energy in KJ/Kg
W=-80;          //work done by the air in the cylinder
    KJ/kg

///Calculation
deltaU=U2-U1;
Q1=deltaU+W;    //Heat transferred during the process

///Output
printf('Heat transferred during the process= %f KJ \
   n',Q1);
```

Scilab code Exa 9.7 `Steam flow rate`

```
///Chapter 9 Law Of Thermodynamics
////Example 9.7 Page No:169
///Find Steam flow rate
///Input data
clc;
clear;
W1=800;                 //Power of turbine shaft Kw
W2=-5;                  //Work pump to feed in Kw
Q1=2700;                //Heat for steam generation KJ/
   Kg
Q2=-1800;               //Condenser rejected heat KJ/Kg

```

```
//Calculation
m=((W1+W2)/(Q1+Q2)); //Steam flow rate in Kg/h


//Output
printf('Steam flow rate= %f Kg/s \n",m);
```

Scilab code Exa 9.8 DeltaUab

```
///Chapter 9 Law Of Thermodynamics
///Example 9.8 Page No:170
/// Find DeltaUab
///input data
clc;
clear;
///Data consistent with first law pf thermodynamics
Qabcd=-22;                        //In KJ
N=150;                            //In Cycles/min
Qab=17580;                        //In KJ/min
Qbc=0;
Qcd=-3660;                        //In KJ/min
Wab=-8160;                        //In KJ/min
Wbc=4170;                        //In KJ/min
DeltaUcd=-21630;                  //In KJ/min


///Calculation
DeltaUab=Qab-Wab;                 //In KJ/min
DeltaUbc=Qbc-Wbc;                 //In KJ/min
Wcd=Qcd-DeltaUcd;                 //In KJ/min
Qabcd1=-220*150;                  //In KJ/min
Qda=((Qabcd1)-(Qab+Qbc+Qcd));     //In KJ/min
Wda=((Qabcd1)-(Wab+Wbc+Wcd));        //In KJ/min
DeltaUabcd=0;
DeltaUda=((DeltaUabcd)-(DeltaUab+DeltaUbc+DeltaUcd))
```

```
; //In KJ/min
NWO=Qabcd1/60;                          //In KW

///Output
printf('DeltaUab= %f Kj/min \n ',DeltaUab);
printf('DeltaUbc= %f KJ/min \n ',DeltaUbc);
printf('Wcd=%f KJ/min \n ',Wcd);
printf('Qabcd1= %f KJ/min \n ',Qabcd1);
printf('Qda= %f KJ/min \n ',Qda);
printf('Wda= %f KJ/min \n ',Wda);
printf('DeltaUabcd= %f KJ/min \n ',DeltaUabcd);
printf('DeltaUda= %f KJ/min \n',DeltaUda);
printf('NWO= %f Kw \n',NWO);
```

Scilab code Exa 9.9 Net heat transfer in 1st cycle

```
///Chapter 9 Law Of Thermodynamics
///Example 9.9 Page No:171
///Find Net heat transfer in 1st cycle
///Input data
clc;
clear;
Qab=-6500;   //Heat transferred in 1st process KJ/min
Qbc=0;       //Heat transferred in 2nd process
Qcd=-10200;  //Heat transferred in 3rd process KJ/min
Qda=32600;   //Heat transferred in 4th process KJ/min
Wab=-1050;   //Heat transferred in 1st process KJ
Wbc=-3450;   //Heat transferred in 2nd process KJ
Wcd=20400;   //Heat transferred in 3rd process KJ
Wda=0;       //Heat transferred in 4th process

///Calculator
dQ=Qab+Qbc+Qcd+Qda; //Net heat transfer in 1st cycle
dW=Wab+Wbc+Wcd+Wda; //Net work done in 1st cycle
dW1=dW/60;          //Net work done in 1st cycle
```

```
DeltaUab=Qab-Wab;    //ab process
DeltaUbc=Qbc-Wbc;    //bc processes
DeltaUcd=Qcd-Wcd;    //cd processes
DeltaUda=Qda-Wda;    //dc processes

///Output
printf('Net heat transfer in 1st cycle= %f KJ/min \n
    ',dQ);
printf('Net work done in 1st cycle= %f KJ/min \n',dW
    );
printf('Net work done in 1st cycle=%f KW \n ',dW1);
printf('ab process= %f KJ/min \n',DeltaUab);
printf('bc processes= %f KJ/min \n ',DeltaUbc);
printf('cd processes= %f KJ/min \n ',DeltaUcd);
printf('dc processes= %f KJ/min \n',DeltaUda);
```

Chapter 10

Properties Of Steam

Scilab code Exa 10.1 Dryness fuction of steam

```
/////Chapter 10 Properties Of Steam
////Example 10.1 Page No:183
///Find Dryness fuction of steam
///Input data
clc;
clear;
mw=15;        //Water steam
ms=185;       //Dry steam

///Calculation
x=((ms)/(ms+mw))*100; //Dryness fuction of steam in
    %

///Output
printf('Dryness fuction of steam= %f percent \n',x);
```

Scilab code Exa 10.2 saturation pressure of the steam

```
/////////Chapter 10 Properties Of Steam
///Example 10.2 Page No:183
/// Find saturation pressure of the steam
//Input data
clc;
clear;
sps=150; //saturation pressure of the steam in degree celsius

//Output
P=4.76; //From steam table
printf('saturation pressure= %f bar \n',P);
```

Scilab code Exa 10.3 Saturation temperature of bar

```
/////////Chapter 10 Properties Of Steam
///Example 10.3 Page No:184
//Find Saturation temperature of bar
///Input data
clc;
clear;
P1=28;       ///Absolute pressure in bar
P2=5.5;      //Absolute pressure in MPa
P3=77;       ///Absolute pressure in mm of Hg

///Calcutation
ts1=230.05; //Saturation temperature in degree celsius
ts2=269.93; //Saturation temperature in degree celsius
ts3=45.83;  //Saturation temperature in degree celsius

///Output
printf('Saturation temperature= %f degree celsius \n
```

```
',ts1);
printf('Saturation temperature= %f degree celsius \n
    ',ts2);
printf('Saturation temperature= %f degree celsius \n
    ',ts3);
```

Scilab code Exa 10.4 Enthalpy of wet steam

```
//////Chapter 10 Properties Of Steam
////Example 10.4 Page No:185
///
////#Input data
clc;
clear;
P=15;                    //Absolute pressure in bar
//From steam table (pressure basis at 15 bar)
ts=198.3;                //In degree celsius
hf=844.7;                //In KJ/Kg
hfg=1945.2;              //In KJ/Kg
hg=2789.9;               //In KJ/Kg
tsup=300;                //In degree celsius
x=0.8;
Cps=2.3;
hg=2789.9;

//Calculation
h1=hf+x*hfg;             //Enthalpy of wet steam in KJ/KG
h=hg;                    //Enthalpy of dry and saturated
    steam in KJ/KG
h2=hg+Cps*(tsup-ts); //Enthalpy of superheated steam
     in KJ/KG


//Output
printf('Enthalpy of wet steam=%f KJ/Kg \n ",h1);
```

```
printf('Enthalpy of dry and saturated steam=%f KJ/Kg \n ',h);
printf('Enthalpy of superheated steam= %f KJ/Kg \n ',h2);
```

Scilab code Exa 10.5 Final Enthalpy of the steam

```
/////////Chapter 10 Properties Of Steam
///Example 7.5 Page No:186
///Find  Final Enthalpy of the steam
//Input data
clc;
clear;
ti=30;          //Temperature in degree celsius
m=2;            //Water in Kg
pf=8;           //Steam at 8 bar
x=0.9;          //Water to dry
tb=30;
///From steam table at 30 degree celsius
hf=125.7;
///h1=hf initial enthalpy of water
///From steam table at 8 bar
ts=170.4;       //In degree celsius
hf1=720.9;      //In KJ/KG
hfg=2046.6;     //In KJ/KG
hg=2767.5;      //In KJ/KG

///Calculation
h=hf1+(x*hfg); //Final Enthalpy of the steam in KJ/Kg
Qha=m*(h-hf);   //Quantity of the heat in KJ/Kg          ///Calculation mistake m is not multiplied by (h-hf) in book

///Output
```

```
printf('Final Enthalpy of the steam=%f KJ/Kg \n ',h)
    ;
printf('Quantity of the heat=%f KJ/Kg \n',Qha);
```

Scilab code Exa 10.6 Enthalpy of superheated steam

```
/////////Chapter 10 Properties Of Steam
///Example 10.6 Page No:186
///Find Enthalpy of superheated steam
///Input data
clc;
clear;
IT=25;                  //Initial temperature
m=5;                    //Heat required to generate
    steam in kg
pf=10;                  //Final pressure in bar
tsup=250;               //Water temperature
///From steam table (temp basis)at 25 degree celsius
//and at 10 bar(pressure basis)
hf=104.8;               //In KJ/KG
h1=104.8;               //In KJ/KG
ts=179.9;               //In degree celsius
hf1=792.6;              //In KJ/KG
hfg=2013.6;             //In KJ/KG
hg=2776.2;              //In KJ/KG
Cps=2.1;

///Calculation
h=hg+Cps*(tsup-ts); //Enthalpy of superheated steam
    in KJ/Kg
H=m*(h-h1);          //Quantity of heat added in KJ/
    Kg

///Output
printf('Enthalpy of superheated steam=%f KJ/Kg \n ",
```

```
h);
printf('Quantity of heat added= %f KJ/Kg \n ",H);
```

Scilab code Exa 10.7 Volume of wet steam

```
/////////Chapter 10 Properties Of Steam
////Example 10.7 Page No:188
///Find Volume of wet steam
///#Input data
clc;
clear;
P=15;                    //Absolute pressure in bar
//From steam table (pressure basis at 15 bar)
ts=198.3+273;            //In degree celsius
vg=0.1317;               //In m^3/Kg
vf=0.001154;             //In m^3/Kg
x=0.8;
Tsup=300+273;            //Degree celsius


//Calculation
v=(1-x)*vf+x*vg;         //Volume of wet steam in m**3/Kg
vg=0.1317;               //Dry and saturated steam in m**3/Kg
vsup=vg*(Tsup/ts);       //Volume of superheated steam m**3/Kg


///Output
printf('Volume of wet steam= %f m^3/Kg \n ',v);
printf('Dry and Saturated Steam= %f m^3/Kg \n ',vg);
printf('volume of superheated steam= %f m^3/kg \n ',vsup);
```

Scilab code Exa 10.8 `Mass of steam`

```
/////////Chapter 10 Properties Of Steam
///Example 10.8 Page No:188
////Find Mass of steam
///Input data
clc;
clear;
P=25;            //Absolute pressure
ts=223.9;        //Volume
//Frome steam table (pressure basis at 25 bar)
vf=0.001197;     //In m^3/Kg
vg=0.0799;       //In m^3/Kg
v=8;             //In m^3/Kg


///Calculation
m=v/vg;          //Mass of steam in Kg

///Output
printf('Mass of steam=%f Kg \n ',m);
```

Scilab code Exa 10.9 `Volume of wet steam`

```
/////////Chapter 10 Properties Of Steam
///Example 10.9 Page No:190
////Find Volume of wet steam

//Input data
clc;
clear;
P=12*10^5;                //Absolute pressure
```

```
//From steam table (pressure basis at 12 bar)
ts=188+273;                 //In degree celsius
vf=0.001139;                //In m**3/Kg
vg=0.1632;                  //In m**3/Kg
hf=798.4;                   //In KJ/Kg
hfg=1984.3;                 //In KJ/Kg
hg=2782.7;                  //In KJ/Kg
x=0.94;
Cps=2.3;
tsup=350+273;               //In degree celsius

//Calcuation
h=hf+x*hfg;                 //Enthalpy of wet steam in KJ/Kg
v=(1-x)*vf+x*vg;            //Volume of wet steam m**3/Kg
u=h-((P*v)/10^3);          //Internal Energy in KJ/Kg
hg=2782.7;                  //Enthalpy of dry & saturated steam in KJ/Kg
v1=vg;                      //Volume of dry & saturated steam  m**3/Kg
u1=hg-((P*vg)/10^3);       //Internal Energy in KJ/Kg
h1=hg+Cps*(tsup-ts);        //Enthalpy of superheated steam in KJ/Kg
vsup=vg*(tsup/ts);          //Volume of superheated steam in m**3/Kg
u2=h1-((P*v)/10**3);        //Internal Energy in KJ/Kg


///Output
printf('Enthalpy of wet steam=%f KJ/Kg \n ',h);
printf('Volume of wet steam= %f m^3/Kg \n ',v);
printf('Internal Energy= %f KJ/Kg \n ',u);
printf('Enthalpy of dry & saturated steam=%f KJ/Kg \n',hg);
printf('Volume of dry & saturated steam=%f m^3/Kg \n ',v1);
printf('Internal Energy= %f KJ/Kg \n',u1);
```

```
printf('Enthalpy of superheated steam=%f KJ/Kg \n ',h1);
printf('Volume of superheated steam= %f m^3/kg \n',vsup);
printf('Internal Energy= %f KJ/Kg \n ',u2);
```

Scilab code Exa 10.10 Enthalpy of superheated steam

```
/////////Chapter 10 Properties Of Steam
/////Example 10.10 Page No:191
////Find Enthalpy of superheated steam
//Input data
clc;
clear;
P1=10*10^5                          //Pressure of steam in bar
tsup1=300+273;                       //Temperature of steam n degree celsius
P2=1.4*10^5;                         //Internal energy of steam
x2=0.8;                              //Dryness fraction
Cps=2.3;
///from steam table properties of saturated steam (temp basis)
///at 25 degree celsius and at 10 bar(pressure basis)
ts1=179.9+273;
vf=0.001127;                         //In m^3/Kg
vg=0.1943;                           //In m^3/Kg
hf=762.6;                            //In KJ/Kg
hfg=2013.6;                          //In KJ/Kg
hg1=2776.2;                          //In KJ/Kg
//at 1.4 bar;
ts=109.3;                            //In degree celsius
vf1=0.001051;                        //In m^3/Kg
```

```
vg1=1.2363;                         //In m^3/Kg
hf1=458.4;                          //In KJ/Kg
hfg1=2231.9;                        //In KJ/Kg
hg=2690.3;                          //In KJ/Kg

///Calculation
h1=hg1+Cps*(tsup1-ts1);             //Enthalpy of
   superheated steam in KJ/Kg
v1=vg*(tsup1/ts1);                  //Volume of
   superheated steam in m**3/Kg
u1=h1-((P1*v1)/10^3);              //Internal energy in KJ
   /Kg
h2=hf1+x2*hfg1;                     //Enthalpy of wet
   steam in KJ/Kg
Vwet=(1-x2)*vf1+x2*vg1;             //Volume of wet steam
   in m**3/Kg
u2=h2-((P2*Vwet)/10^3);            //Internal energy in KJ
   /Kg
DeltaU=u1-u2;                       //Change of Internal
   energy in KJ/Kg


//Output
printf('Enthalpy of superheated steam= %f KJ/Kg \n '
   ,h1);
printf('Volume of superheated steam=%f m^3/kg \n ',
   v1);
printf('Internal energy= %f KJ/Kg \n ',u1);
printf('Enthalpy of wet steam= %f KJ/Kg \n ',h2);
printf('Volume of wet steam=%f m^3/kg \n ',Vwet);
printf('Internal energy= %f KJ/Kg \n',u2);
printf('Change of Internal energy= %f KJ/Kg \n ',
   DeltaU);
```

Scilab code Exa 10.11 `Entropy of wet steam`

```
/////////Chapter 10 Properties Of Steam
//////Example 10.11 Page No:193
/////Find Entropy of wet steam
///Input data
clc;
clear;
P=15;                              //Absolute pressure
//From steam table (pressure basis at 15 bar)
ts=198.3+273;                      //In degree celsius
Sf=2.3145;                         //In KJ/KgK
Sfg=4.1261;                        //In KJ/KgK
Sg=6.4406;                         //In KJ/KgK
tsup=300+273;
Cps=2.3;
x=0.8;

////calculation
S=Sf+x*Sfg;                         //Entropy of wet
   steam in KJ/Kg
S1=Sg;                              //Entropy of
   superheated steam in KJ/Kg
S2=Sg+Cps*(log(tsup/ts)); //Entropy of superheated
   steam in  KJ/Kg

///Output
printf('Entropy of wet steam %f KJ/Kg \n' ,S);
printf('Entropy of dry and saturated steam %f KJ/Kg
   \n ' ,S1);
printf('Entropy of superheated steam %f KJ/Kg \n' ,
   S2);
```

Scilab code Exa 10.12 Entropy of of superheated steam

```
/////////Chapter 10 Properties Of Steam
/////Example 10.12 Page No:194
```

```
///Entropy of 1.5Kg of superheated steam

//Input data
clc;
clear;
m=1.5;                        //Entropy of the steam
P=10*10^5;                   //Absolute pressure in bar
//From steam table properties of saturated steam
///(pressure basis)at 10 bar
ts=179.9+273;                 //Indegree celsius
vf=0.001127;                  //In m**3/Kg
vg=0.1943;                    //In m**3/Kg
hf=762.6;                     ///In KJ/Kg
hfg=2013.6;                   //In KJ/Kg
hg=2776.2;                    //In KJ/Kg
Sf=2.1382;                    //In KJ/KgK
Sfg=4.4446;                   //In KJ/KgK
Sg=6.5828;                    //In KJ/Kg
Cps=2.3;
tsup=250+273;


///Calculation
//(1)Enthalpy of dry and saturated steam

h=hg;                         //Enthalpy of dry and saturated steam
EODS=hg*m;                    //Enthalpy of 1.5Kg of dry and saturated steam
v=vg;                         //volume of dry and saturated steam
u=h-((P*v)/10^3);            //Internal Energy
IES=u*m;                      //Internal energy of the steam
s=6.5858;                     //Entropy of dry and saturated steam
EODSS=s*m;                    //Entropy of 1.5Kg dry and saturated steam
```

```
x=0.75;
//(2)Enthalpy of wet steam
h1=hf+x*hfg;                //Enthalpy of wet steam
EWS=h1*m;                   //Enthalpy of1.5Kg of wet
   steam
Vwet=x*vg;                  //Volume of steam
u1=h1-((P*Vwet)/10^3); //Internal energy
IES1=u1*m;                  //Internal energy of1.5Kg of
    the steam
s1=Sf+x*Sfg;                //Entropy of wet steam
EWS1=s1*m;                  //Entropy of1.5Kg of wet
   steam

///(3)Enthalpy of superheated steam
h2=hg+Cps*(tsup-ts);        //Enthalpy of superheated
   steam
EOSHS=h2*m;                 //Enthalpy of 1.5Kg of
   superheated steam
Vsup=vg*(tsup/ts);          //Volume of superheated
   steam
u2=h2-((P*Vsup)/10^3); //Internal energy
IES2=u2*m;                  //Internal energy of 1.5Kg
   of the steam
s2=Sg+Cps*(log(tsup/ts));//Entropy of superheated
   steam
EOSHS1=s2*m;                //Entropy of 1.5Kg of
   superheated steam

///Output
printf('Enthalpy of dry and saturated steam= %f KJ/
   Kg \n  ',h);
printf('Enthalpy of 1.5Kg of dry and saturated steam
   = %f KJ \n ',EODS);
printf('volume of dry and saturated steam= %f m^3/Kg
    \n ',v);
printf('Internal Energy= %f KJ/Kg \n  ',u);
printf('Internal energy of the steam= %f KJ \n  ',
   IES);
```

```
printf('Entropy of dry and saturated steam = %f KJ/
    KgK \n ',s);
printf('Entropy of 1.5kg of dry and saturated steam=
     %f KJ/K \n  ',EODSS);

printf('Enthalpy of wet steam= %f KJ/Kg \n ',h1);
printf('Enthalpy of1.5Kg of wet steam=  %f KJ \n ',
    EWS);
printf('Volume of steam= %f m^3/Kg \n',Vwet);
printf('Internal energy= %f KJ/Kg \n  ',u1);
printf('Internal energy of1.5Kg of the steam= %f KJ
    \n  ',IES1);
printf('Entropy of wet steam= %f KJ/KgK \n  ',s1);
printf('Entropy of 1.5Kg of wet steam= %f KJ/K \n  '
    ,EWS1);

printf('Enthalpy of superheated steam= %f KJ/Kg \n
    ',h2);
printf('Enthalpy of 1.5Kg of superheated steam= %f
    KJ \n  ',EOSHS);
printf('Volume of superheated steam= %f m^3/Kg \n',
    Vsup);
printf('Internal energy= %f \n  ',u2);
printf('Internal energy of1.5Kg of the steam= %f KJ
    \n  ',IES2);
printf('Entropy of superheated steam= %f KJ/KgK \n
    ',s2);
printf('Entropy of 1.5Kg of superheated steam= %f KJ
    /K \n  ',EOSHS1);
```

Scilab code Exa 10.13 `Volume occupied by water`

```
/////////Chapter 10 Properties Of Steam
////Example 10.13 Page No:196
////Find Volume occupied by water
```

```
///Input data
clc;
clear;
V=0.04;                        //Volume of vessel in m^3
x=1;
t=250+273;                     //Saturated steam temp in degree celsius
mw=9;                          //Mass of liquid in Kg
//From steam table(temp basis,at t=250)
P=39.78*10^5;                     //in bar
Vf=0.001251;                   //In m^3/kg
Vg=0.05004;                    //In m^3/Kg
hf=1085.7;                     //KJ/Kg
hfg=2800.4;                    //KJ/Kg
hg=1714.7;                     //KJ/Kg

//Calculation
Vw=mw*Vf;                      //Volume occupied by water in m^3
Vs=V-Vw;                       //Volume of waterin m^3
ms=Vs/Vg;                      //Volume of dry and saturated steam in Kg
m=mw+ms;                       //Total mass of steam in Kg
x=ms/(ms+mw);                  //Dryness fraction of steam
Vwet=(1-x)*Vf+x*Vg;            //Specific volume of steam in m^3/Kg
h=hf+x*hfg;                    //Enthalpy of wet steam in KJ/Kg
EOWS=h*m;                      //Enthalpy of 9.574 Kg of wet steam KJ
u=h-((P*Vwet)/10^3);          //Internal Energy in KJ/Kg
IEOS=u*m;                      //Internal energy of 9.574 Kg of steam in KJ


///Output
printf('Volume occupied by water=%f m^3 \n ',Vw);
printf('Volume of water=%f m^3 \n ',Vs);
```

```
printf('Volume of dry and saturated steam=%f Kg \n',
   ms);
printf('Total mass of steam= %f Kg \n ',m);
printf('Dryness fraction of steam= %f  \n',x);
printf('Specific volume of steam=%f m^3/Kg \n ',Vwet
   );
printf('Enthalpy of wet steam=%f KJ/Kg \n ',h);
printf('Enthalpy of 9.574 Kg of wet steam=%f KJ \n '
   ,EOWS);
printf('Internal Energy= %f KJ/Kg \n',u);
printf('Internal energy of 9.574 Kg of steam=%f KJ \
   n ',IEOS);
```

Scilab code Exa 10.14 Degree of superheat

```
/////////Chapter 10 Properties Of Steam
///Example 10.14 Page No:197
//// Find Degree of superheat
///Input Data
clc;
clear;
P=7;                    //Absolute pressure in bar
t=200;                  //Absolute temperature
ts=165;                 //In degree celsius from steam
   table

//Calculation
dos1=t-ts;               //Degree of superheat in
   degree celcius

//Output
printf('Degree of superheat=%f degree celsius \n ',
   dos1);
```

Scilab code Exa 10.15 `Enthalpy of wet steam`

```
/////////Chapter 10 Properties Of Steam
///Example 15 Page No:197
///Find Enthalpy of wet steam
///Input data
clc;
clear;
P=15;           ///Absolute pressure in bar
///From steam table (pressure basis at 15 bar)
h=1950;         //In KJ/Kg
ts=198.3;       //In degreee celsius
hf=844.7;       //In KJ/Kg
hfg=1945.2;     //In KJ/Kg
hg=2789.9;      //In KJ/Kg

///Calculation
x=((h-hf)/hfg);   ///Enthalpy of wet steam

///Output
printf('Enthalpy of wet steam=%f \n ',x);
```

Scilab code Exa 10.16 `Enthalpy of superheated steam`

```
/////Chapter 10 Properties Of Steam
////Example 10.16 Page No:197
///Find Enthalpy of superheated steam
//Input data
clc;
clear;
P=15;                           //Absolute pressure in
   bar
```

```
//From steam table (pressure basis at 15 bar)
h=3250;                          //In KJ/Kg
ts=198.3;                        //In degree celsius
hf=844.7;                        //In KJ/Kg
hfg=1945.2;                      //In KJ/Kg
hg=2789.9;                       //In KJ/Kg
Cps=2.3;

//Calculation
tsup=(h-hg+(Cps*ts))/2.3, //Enthalpy of superheated steam in degree celsius
dos1=tsup-ts;                    //Degree of superheated in degree celsius
                               //The value of ts in not used according to data in book instead of ts =198.3 author used ts =165

//Output
printf('Enthalpy of superheated steam= %f degree celcius\n   ',tsup);
printf('Degree of superheated=%f degree celcius \n   ',dos1);
```

Scilab code Exa 10.17 `Volume of steam dryness fraction`

```
///Chapter 10 Properties Of Steam
///Example 10.17 Page No:198
///Find Volume of steam dryness fraction
//Input data
clc;
clear;
P=7;                      //Absolute pressure in bar
v=0.2;                    //Specific volume in m^3/Kg
```

```
//from steam table (pressure basis at 7 bar)
ts=165;                 //In degree celsius
vf=0.001108;            //In m^3/Kg
vg=0.2727;              //In m^3/Kg

//Calculation
x=v/vg;                 //Volume of steam dryness
   fraction

//Output
printf('Volume of steam dryness fraction= %f \n',x);
```

Scilab code Exa 10.18 `Temp of superheated steam`

```
////////Chapter 10 Properties Of Steam
////Example 10.18 Page No:198
///Find Temp of superheated steam
///Input data
clc;
clear;
P=7;                            //Absolute pressure
    in bar
v=0.3;                          //Specific volume
   in m^3/Kg
//From steam table (pressure basis at 7 bar)
ts=165+273;                     //In degree celsius
vf=0.001108;                    //In m^3/Kg
vg=0.2727;                      //In m^3/Kg

///Calculation
//v=vg*tsup/ts;
tsup=((v/vg)*ts)-273;           //Temp of
   superheated steam  in degree celsius
DOS=tsup+273-ts;                //Degree of
   superheated  in degree celsius
```

```

//Output
printf('Temp of superheated steam=%f degree celsius
   \n ',tsup);
printf('Degree of superheated=%fdegree celsius \n  '
   ,DOS);
```

Scilab code Exa 10.19 `Quality of steam`

```
/////////Chapter 10 Properties Of Steam
///Example 10.19 Page No:198
///Find Quality of steam
///Input data
clc;
clear;
m=2;          //steam of vessel in Kg
V=0.1598;     //volume of vessel in M**3
P=25;         //Absolute pressure of vessel in bar

//Calculation
v=V/m;        //Quality of steam in m**3/Kg

//Output
printf('Quality of steam %f m^3/Kg \n' ,v);
```

Scilab code Exa 10.20 `Initial enthalpy of steam`

```
/////////Chapter 10 Properties Of Steam
////Example 10.20 Page No:200
/// Find Initial enthalpy of steam
//Input data
clc;
clear;
```

```
P=10*10^2;                    //Absolute pressure in bar
x1=0.9;                        //Dryness enters
tsup2=300+273;                 //Temperature in degree celsius
//From steam table at 10 bar
ts=179.9+273;                  //In degree celsius
Vg=0.1943;                     //In m^3/Kg
hf=762.6;                      //In KJ/Kg
hfg=2013.6;                    //InK/Kg
hg=2776.2;                     //In KJ/Kg
Cps=2.3;

//Calculation
h1=hf+x1*hfg;                  //Initial enthalpy of steam in KJ/Kg
V1=x1*Vg;                      //Initial specific volume of steam
u1=h1-P*V1;                    //Initial internal energy of steam in KJ/Kg
h2=hg+Cps*(tsup2-ts);          //Final enthalpy of steam in KJ/Kg
V2=Vg*(tsup2/ts);              //Final specific volume of steam in m**3/Kg
u2=h2-P*V2;                    //Final internal energy of steam in KJ/K
deltah=h2-h1;                  //Heat gained by steam in KJ/Kg
deltaU=(u2-u1);                //Change in internal energy in KJ/Kg

//Output
printf('Initial enthalpy of steam=%f KJ/Kg \n',h1);
printf('Initial specific volume of steam=%f \n ',V1)
    ;
printf('Initial internal energy of steam=%f KJ/Kg \n
    ',u1);
printf('Final enthalpy of steam= %f KJ/Kg \n ',h2);
printf('Final specific volume of steam= %f m^3/kg \n
```

```
   ',V2);
printf('Final internal energy of steam=%f Kj/Kg \n '
   ,u2);
printf('Heat gained by steam= %f KJ/Kg \n ',deltah);
printf('Change in internal energy=%f KJ/Kg \n ',
   deltaU);
```

Scilab code Exa 10.21 Final Enthalpy of steam

```
/////////Chapter 10 Properties Of Steam
///Example 10.21 Page No:201
/// Find Final  enthalpy of steam
//Input data
clc;
clear;
m=4;                          //Steam in Kg
P=13;                         //Absolute pressure in
   bar
tsup1=450;                    //Absolute temp in
   degree celsius
deltaH=2.8*10^3;
Cps=2.3;             //loses in MJ
//from steam table at 13 bar
ts=191.6;                     //In degree celsius
Vg=0.1511;                    //In m^3/Kg
hf=814.7;                     //In m^3/Kg
hfg=1970.7;                   //In  KJ/Kg
hg=2785.4;                    //In KJ/Kg

///Calculation
h1=hg+Cps*(tsup1-ts);         //Initial enthalpy of
   steam in KJ/Kg
Deltah=deltaH/m;              //Change in enthalpy/
   unit mass in KJ/Kg
h2=h1-Deltah;                 //Final enthalpy of
```

```
steam in KJ/Kg
x2=(h2-hf)/hfg;                    //wet & dryness fraction

//Output
printf('Initial enthalpy of steam=%f Kj/Kg \n ',h1);
printf('Change in enthalpy/unit mass=%f Kj/Kg \n ', Deltah);
printf('Final enthalpy of steam= %f KJ/Kg \n',h2);
printf('wet & dryness fraction=%f \n',x2);
```

Scilab code Exa 10.22 `Initial specific volume of steam`

```
/////////Chapter 10 Properties Of Steam
///Example 10.22 Page No:201
//Find Initial specific volume of steam
//Input data
clc;
clear;
m=2;                               //Steam in Kg
x=0.7;                             //Initial dryness
P=15;                              //Constant pressure in bar
//V2=2V1
//from steam table properties of
//saturated steam(pressure basis) at 15 bar
Ts=198.3+273;                      //In degree celsius
Vg=0.1317;                         //In m^3/Kg
hf=844.7;                          //In KJ/Kg
hfg=1945.2;                        //In KJ/Kg
hg=2789.9;                         //In KJ/Kg
Cps=2.3;

///Calculation
V1=x*Vg;                           //Initial specific volume of steam in m**3/Kg
```

```
V2=2*V1;                              //Final specific volume of steam in m**3/Kg
Tsup=(V2/Vg)*Ts;                      //Steam is superheated in degree celsius
FSS=Tsup-Ts;                          //Degree of superheated in degree celsius
h1=hf+x*hfg;                          //Initial enthalpy of steam in KJ/Kg
h2=hg+Cps*(Tsup-Ts);                  //Final enthalpy of steam in KJ/Kg
Q=(h2-h1)*m;                          //Heat transferred in the process in KJ
W1=P*(m*V2-m*V1);                     //Work transferred in the process in KJ

//Output
printf('Initial specific volume of steam=%f m^3/kg \n',V1);
printf('Final specific volume of steam= %f m^3/kg \n',V2);
printf('Steam is superheated= %f K \n ',Tsup);
printf('Degree of superheated=%f degree celsius \n ',FSS);
printf('Initial enthalpy of steam=%f KJ/Kg \n ',h1);
printf('Final enthalpy of steam=%f KJ/Kg \n ',h2);
printf('Heat transferred in the process=%f KJ \n ',Q);
printf('Work transferred in the process= %f KJ \n',W1);
```

Scilab code Exa 10.23 Constant pressure process

```
/////////Chapter 10 Properties Of Steam
///Example 10.23 Page No:203
///Find Constant pressure process
```

```
//Input data
clc;
clear;
ms=1000;                          //Steam in Kg/h
P=16;                             //Absolute pressure in bar
x2=0.9;                           //Steam is dry
t1=30+273;                        //temperature in degree celsius
tsup=380;                         //tmperature rised in degree celsius

//from steam table(pressure basis at 16 bar)
h1=125.7;                         //in KJ/Kg
ts=201.4;                         //In degree celsius
hf=858.5;                         //in kJ/Kg
hfg=1933.2;                       //in kJ/Kg
hg=2791.7;                        //in kJ/Kg
Cps=2.3;

//Calculation
h2=hf+x2*hfg;                     //Final enthalpy of wet steam in KJ/Kg
Q1=(ms*(h2-h1))*(10^(-3));           //Constant pressure process in KJ/h
h3=hg+Cps*(tsup-ts);              //Final enthalpy of superheated steam in KJ/g
Q2=(ms*(h3-h2))*(10^(-3));           //Suprheated steam in KJ/h

//Output
printf('Final enthalpy of wet steam= %f KJ/Kg \n ',h2);
printf('Constant pressure process= %f KJ/h \n',Q1);
printf('Final enthalpy of superheated steam= %f KJ/g \n',h3);
printf('Suprheated steam= %f KJ/h \n',Q2);
```

Scilab code Exa 10.24 `Enthalpy of steam of first boiler`

```
/////////Chapter 10 Properties Of Steam
///Example 10.24 Page No:204
///Find Enthalpy of steam of first boiler
clc;
clear;
//Input data;
FB=15;                    //First boiler in bar
SB=15;                    //Second boiler in bar
tsup1=300;                //Temperature of the steam in degree celsius
tsup2=200;                //Temperature of the steam in degree celsius
//From steam table (pressure basis at 15 bar )
ts=198.3;                 //In degree celsius
hf=844.7;                 //In KJ/Kg
hfg=1945.2;               //In KJ/Kg
hg=2789.9;                //In KJ/I
Cps=2.3;

//Calculation
h1=hg+Cps*(tsup1-ts);     //Enthalpy of steam of first boiler in KJ/Kg
h3=hg+Cps*(tsup2-ts);     //Enthalpy of steam in steam main in KJ/Kg
h2=2*h3-h1;               //Energy balance in KJ/Kg
x2=(h2-hf)/hfg;           //Enthalpy of wet steam

//OUTPUT
printf('Enthalpy of steam of first boiler= %f KJ/Kg\n',h1);
printf('Enthalpy of steam in steam main=%f KJ/Kg \n',h3);
```

```
printf('Energy balance=%f KJ/Kg \n ',h2);
printf('Enthalpy of wet steam= %f \n ',x2);
```

Scilab code Exa 10.25 `Initial specific volume of steam`

```
/////////Chapter 10 Properties Of Steam
///Example 10.25 Page No:205
// Find Initial specific volume of steam
clc;
clear;
///Input data
V=0.35;                         //Capacity of vessel in m^3
P1=10*10^2;                    //Absolute pressure in bar
tsup1=250+273;                  //Absolute temperature in degree celsius
P2=2.5*102;                     //Absolute pressure in the vessel fall in bar

//From steam table (pressure basis at 10 bar)
ts1=179.9+273;                  //In degree celsius
Vg1=0.1943;                     //In m^3/Kg
hf1=762.6;                      //In KJ/Kg
hfg1=2013.6;                    //In KJ/Kg
hg1=2776.2;                     //In KJ/Kg

//From steam table(pressure basis at 2.5 bar)
V2=0.2247;                      //In m^3/Kg
ts2=127.4;                      //In degree celsius
Vg2=0.7184;                     //In m^3/Kg
hf2=535.3;                      //In KJ/Kg
hfg2=2181.0;                    //In KJ/Kg
hg2=2716.4;                     //In KJ/Kg
Cps=2.3;
```

```
///Calculation
V1=Vg1*(tsup1/ts1);            //Initial specific
   volume of steam in m^3/Kg
m=V/V1;                        //Initial mass of steam
   in Kg
x2=V2/Vg2;                     //Final condition of wet
    steam
h1=hg1+Cps*(tsup1-ts1);        //Initial enthalpy of
   steam in KJ/Kg
u1=h1-P1*V1;                   //Initial internal
   energy of steam in KJ/Kg
h2=hf2+x2*hfg2;                //Final enthalpy of
   steam in KJ/Kg
u2=h2-P2*V2;                   //Final internal energy
   of steam in KJ/Kg
deltaU=(u2-u1)*m;              //Change in internal
   energy in KJ

//Output
printf('Initial specific volume of steam=%f m^3/Kg \
   n ',V1);
printf('Initial mass of steam=%fKg \n ',m);
printf('Final condition of wet steam= %f \n ',x2);
printf('Initial enthalpy of steam=%f KJ/Kg \n ',h1);
printf('Initial internal energy of steam= %f KJ/Kg \
   n',u1);
printf('Final enthalpy of steam=%f KJ/Kg \n ',h2);
printf('Final internal energy of steam=%f KJ/Kg \n',
   u2);
printf('Change in internal energy= %f KJ/Kg \n',
   deltaU);
```

Scilab code Exa 10.26 Constant volume process

```
/////////Chapter 10 Properties Of Steam
```

```
///Example 10.26 Page No:207
//Find Constant volume process
clc;
clear;
//Input data
m=1.5;                                  //Saturated steam in Kg
x1=1;
x2=0.6;
P1=5*10^5;                              //Absolute  pressure in bar
//From steam table at pressure basis 5 bar
hg1=2747.5;                             //In KJ/Kg
Vg1=0.3747;                             //In m^3/Kg
V1=0.3747;                              //In m^3/Kg
V2=0.3747;                              //In m^3/Kg
//From steam table at Vg2 is 2.9 bar
P2=2.9*10^5;                            //Absolute pressure in bar
t2=132.4;                               //In degree celsius
hf2=556.5;                              //In KJ/Kg
hfg2=2166.6;                            //In KJ/Kg



//Calculation
Vg2=V2/x2;                               //Constant volume process in m^3/Kg
u1=hg1-((P1*Vg1)/1000);                  //Initial internal energy in KJ/Kg
u2=(hf2+x2*hfg2)-((P2*V2)/1000);  //Final internal energy in KJ
deltaU=(u1-u2)*m;                        //Heat supplied in KJ

//Output
printf('Constant volume process=%f m^3/Kg \n ',Vg2);
printf('Initial internal energy=%f KJ/Kg \n ',u1);
```

```
printf('Final internal energy= %f KJ \n',u2);
printf('Heat supplied=%f KJ \n ',deltaU);
```

Scilab code Exa 10.27 Enthalpy of steam

```
/////////Chapter 10 Properties Of Steam
///Example 10.27 Page No:208
//Find Enthalpy of steam
clc;
clear;
//Input data
P1=20;              //Initial steam in bar
x1=0.95;            //dryness throttled
P2=1.2;             //Absolute pressure in bar

//From steam table (pressure basis at 20 bar)
ts=212.4;           //In degree celsius
hf=908.6;           //In KJ/Kg
hfg=1888.6;         //In KJ/Kg
hg=2797.2;          //In KJ/Kg
//From steam table (pressure basis at 1.2 bar)
//h2=h1;              //In KJ/Kg
ts2=104.8;          //In degree celsius
hf2=439.3;          //In KJ/Kg
hfg2=2244.1;        //In KJ/Kg
hg2=2683.4;         //In KJ/Kg
Cps=2.3;


//Calculation
h1=hf+x1*hfg;       //Enthalpy of steam in KJ/Kg
tsup2=((h1-hg2)/Cps)+ts2; //Enthalpy of wet steam in
    degree celsius
DOS=tsup2-ts2;      //Degree of superheat in degree
   celsius
```

```



//Output
printf('Enthalpy of steam=%f KJ/Kg \n ',h1);
printf('Enthalpy of wet steam=%f degree celsius \n ',tsup2);
printf('Degree of superheat=%f degree celsius \n',DOS);
```

Scilab code Exa 10.28 Enthalpy after throttling

```
/////////Chapter 10 Properties Of Steam
///Example 10.28 Page No:209
///Enthalpy after throttling
//Input data
clc;
clear;
P1=12;              //Throttled steam
x1=0.96;            //Dryness is brottled
x2=1;               //Constant enthalpy process
//From steam table at12 bar
ts=188;             //In degree celsius
hf=798.4;           //In KJ/Kg
hfg=1984.3;         //In KJ/Kg
hg=2782.7;          //In KJ/Kg


//Calculation
h1=hf+x1*hfg;       //Enthalpy of the steam  in KJ/Kg
h2=h1;              //Enthalpy after throttling in KJ/Kg

///Output
printf('Enthalpy of the steam=%f KJ/Kg \n ',h1);
printf('Enthalpy after throttlin= %f KJ/Kg \n',h2);
```

Scilab code Exa 10.29 Entropy of of superheated steam

```
/////////Chapter 10 Properties Of Steam
///Example 10.29 Page No:210
///Find Entropy  of superheated steam
//Input data
clc;
clear;
P1=15;                              //Initial steam in
   bar
tsup1=250+273;                      //Temperature of
   steam in degree celsius
P2=0.5;                             //Steam turbine in
   bar

//From steam table at 15 bar
ts1=198.3+273;                      //In degree celsius
hg1=2789.9;                         //In KJ/Kg
sf1=2.3145;                         //In KJ/KgK
sfg1=4.1261;                        //In KJ/KgK
sg1=6.4406;                         //In KJ/KgK
//From steam table at 0.5 bar
ts2=81.53;                          //In degree celsius
sf2=1.0912;                         //In KJ/Kg
sfg2=6.5035;                        //In KJ/Kg
sg2=7.5947;                         //In KJ/Kg
hf2=340.6;
Cps=2.3;
hfg2=2646;

//Calculation
S1=sg1+Cps*(log(tsup1/ts1)); //Entropy  of
   superheated steam in KJ/KgK
S2=S1                                 //Entropy after
```

```
isentropic processes in KJ/KgK
x2=(S2-sf2)/sfg2;                          //Enthalpy of wet
   steam
h1=hg1+Cps*(tsup1-ts1);                    //Enthalpy of
   steam at 15 bar
h2=hf2+x2*hfg2;                            //Enthalpy of wet
   steam at 0.5 bar
WOT=h1-h2;                                 //Work output of
   the turbine

///OUTPUT
printf('Entropy  of superheated steam= %f KJ/KgK \n
   ',S1);
printf('Entropy after isentropic processes=%f KJ/KgK
   \n' ,S2);
printf('Enthalpy of wet steam= %f \n',x2);
printf('Enthalpy of steam= %f KJ/Kg',h1);
printf('Enthalpy of wet steam= %f KJ/Kg \n',h2);
printf('Work output of the turbine=%f KJ/Kg \n ',WOT
   );
```

Chapter 11

Steam Boilers

Scilab code Exa 11.1 Mass of evaporation

```
///Chapter No 11 Steam Boilers
////Example 11.1 Page No 228
///Find Mass of evaporation
//Input data
clc;
clear;
ms=5000;                    //Boiler produces wet steam
    in Kg/h
x=0.95;                     //Dryness function
P=10;                       //Operating pressure in bar
mf=5500;                    //Bour in the furnace in Kg
Tw=40;                      //Feed water temp in degree
    celsius

//Calculation
//from steam table
hfw=167.45;                 //In KJ/Kg
hf=762.61;                  //In KJ/Kg
hfg=2031.6;                 //In KJ/Kg
hs=(hf+x*hfg);              //Enthalpy of wet stream in
    KJ/Kg
```

```
me=ms/mf;                    //Mass of evaporation
E=((me*(hs-hfw))/(2257))*10; //Equivalent evaporation in Kg/Kg of coal

//Output
printf('Enthalpy of wet stream=%f KJ/Kg \n',hs);
printf('Mass of evaporation=%f KJ/Kg \n',me);
printf('Equivalent evaporation = %f Kg/Kg of coal \n',E);
```

Scilab code Exa 11.2 `Enthalpy of wet stream`

```
///Chapter No 11 Steam Boilers
////Example 11.2 Page No 229
///Find Enthalpy of wet stream
///Input data
clc;
clear;
p=14;                         //Boiler pressure in bar
me=9;                         //Evaporates of water in Kg
Tw=35;                        //Feed water entering in degree celsius
x=0.9;                        //Steam stop value
CV=35000;                     //Calorific value of the coal

///Calculation
//From Steam Table
hfw=146.56;                   //In KJ/Kg
hf=830.07;                    //In KJ/Kg
hfg=1957.7;                   //In KJ/Kg
hs=hf+x*hfg;                  //Enthalpy of wet stream in KJ/Kg
```

```
E=((me*(hs-hfw))/2257);           //Equivalent
   evaporation in Kg/Kg of coal
etaboiler=((me*(hs-hfw))/CV)*100;//Boiler efficiency
    in %

///Output
printf('Enthalpy of wet stream=%f KJ/Kg \n',hs);
printf('Equivalent evaporation=%f Kg/Kg of coal \n',
   E);
printf('Boiler efficiency=%f percent \n',etaboiler);
```

Scilab code Exa 11.3 `mass of evaporation`

```
///Chapter No 11 Steam Boilers
////Example 11.3 Page No 230
///Find mass of evaporation
//Input data
clc;
clear;
ms=2500;                              //Saturated steam
   per bour in Kg
x=1;
P=15;                                 //Boiler pressure
   in bar
Tw=25;                                //Feed water
   entering in degree celsius
mf=350;                               //Coal burnt in Kg
   /bour
CV=32000;                             //Calorific value
   in Kj/Kg

//Calculation
//steam table
hfw=104.77;                           //In KJ/Kg
hf=844.66;                            //In KJ/Kg
```

```
hfg=1945.2;                          //In KJ/Kg
hg=2789.9;                           //In KJ/Kg
hs=2789.9;                           //Enthalpy of dry
   steam in KJ/Kg
me=ms/mf;                            //mass of
   evaporation
E=((me*(hs-hfw))/2257);              //Equivalent
   evaporation in Kg/Kg ofcoal
etaboiler=((me*(hs-hfw))/CV)*100;  //Boiler
   efficiency in %

//Output
printf('mass of evaporation= %f \n',me);
printf('Equivalent evaporation= %f Kg/Kg of coal\n',
   E);
printf('Boiler efficiency= %f percent \n',etaboiler)
   ;
```

Scilab code Exa 11.4 Enthalpy of superheated steam

```
///Chapter No 11 Steam Boilers
////Example 11.4 Page No 231
///Find Enthalpy of superheated steam
//Input data
clc;
clear;
mf=500;                              //Boiler plant
   consumes of coal in Kg/h
CV=32000;                            //Calorific value
   in Kj/Kg
ms=3200;                             //plant generates
   in Kg/h
P=1.2;                               //Absolute pressure
    MN/m^2
MN=12;
```

```
Tsup=300;                              //Absolute temperature in degree celsius
Tw=35;                                 //Feed water temperature
Cps=2.3;

//Calculation
hfw=146.56;                            //In KJ/Kg
Ts=187.96;                             //In Degree celsius
hf=798.43;                             //In KJ/Kg
hfg=1984.3;                            //In KJ/Kg
hg=2782.7;                             //In KJ/Kg
hs=hg+Cps*(Tsup-Ts);                   //Enthalpy of superheated steam in KJ/Kg
me=ms/mf;                              //mass of evaporation
E=((me*(hs-hfw))/2257);                //Equivalent evaporation in Kg/Kg ofcoal
etaboiler=((me*(hs-hfw))/CV)*100; //Boiler efficiency in %


///Output
printf('Enthalpy of superheated steam= %f KJ/Kg\n',hs);
printf('mass of evaporation=%f \n',me);
printf('Equivalent evaporation=%f Kg/Kg of coal \n',E);
printf('Boiler efficiency %f percent \n ',etaboiler);
```

Scilab code Exa 11.5 Enthalpy of wet stream

```
///Chapter No 11 Steam Boilers
////Example 11.5 Page No 232
```

```
//Find Enthalpy of wet stream
//Input data
clc;
clear;
ms=5000;                              //Steam generted in Kg/h
mf=700;                               //Coal burnt in Kg/h
CV=31402;                             //Cv of coal in KJ/Kg
x=0.92;                               //quality of steam
P=1.2;                                //Boiler pressure in MPa
Tw=45;                                //Feed water temperature in degree celsius


//Calculation
hfw=188.35;                           //In KJ/Kg
hf=798.43;                            //In KJ/Kg
hfg=1984.3;                           //In KJ/Kg
hs=hf+x*hfg;                          //Enthalpy of wet stream in KJ/Kg
me=ms/mf;                             //mass of evaporation
E=((me*(hs-hfw))/2257);               //Equivalent evaporation in Kg/Kg of coal
etaboiler=((me*(hs-hfw))/CV)*100;     //Boiler efficiency in %



//Output
printf('Enthalpy of wet stream= %f KJ/Kg \n',hs);
printf('mass of evaporation=%f \n',me);
printf('Equivalent evaporation=%f Kg/Kg of coal \n',E);
```

```
printf('Boiler efficiency=%f percent \n',etaboiler);
```

Scilab code Exa 11.6 Boiler efficiency

```
///Chapter No 11 Steam Boilers
////Example 11.6 Page No 233
///Enthalpy of superheated steam
//Input data
clc;
clear;
ms=6000;                          //Boiler produce of steam Kg/h
P=25;                             //Boiler pressure in bar
Tsup=350;                         //Boiler temperature in degree celsius
Tw=40;                            //Feed water temperature indegree celsius
CV=42000;                         //Calorific value in Kj/Kg
etaboiler=75/100;                 //Expected thermal efficiency in %


//Calculation
hfw=167.45;                       //In KJ/Kg
Ts=223.94;                        //In degree celsius
hf=961.96;                        //In KJ/Kg
hfg=1839.0;                       //In KJ/Kg
hg=2800.9;                        //In KJ/Kg
Cps=2.3;
hs=((hg)+(Cps)*(Tsup-Ts));            //Enthalpy of superheated steam KJ/Kg
mf=((ms*(hs-hfw))/(CV*etaboiler)); //Boiler efficiency in %
me=ms/mf;                             //Equivalent mass
```

```
    of evaporation
E=((me*(hs-hfw))/2257);            //Equivalent
    evaporation in Kg/Kg of oil


//Output
printf('Enthalpy of superheated steam=%f KJ/Kg \n',
    hs);
printf('Boiler efficiency=%f percent \n',mf);
printf('Equivalent mass of evaporation=%f \n',me);
printf('Equivalent evaporation=%fKg/Kg of oil \n' ,E
    );
```

Scilab code Exa 11.7 `Boiler efficiency`

```
///Chapter No 11 Steam Boilers
////Example 11.7 Page No 234
///Find Boiler efficiency
///Input data
clc;
clear;
E=12;                          //Boiler found steam in
     Kg/Kg
CV=35000;                      //Calorific value in KJ
    /Kg
ms=15000;                      //Boiler produces in Kg
    /h
P=20;                          //Boiler pressure in
    bar
Tw=40;                         //Feed water in degree
    celsius
mf=1800;                       //Fuel consumption


//Calculation
```

```
//R=me(hs-hfw)
hfw=167.45;                  //In KJ/Kg
hg=2797.2;                   //In KJ/Kg
Ts=211.37;                   //In degree celsius
Cps=2.3;
R=E*2257;                    //Equivalent evaporation in KJ/Kg of coal
etaboiler=(R/CV)*100;        //Boiler efficiency in %
me=ms/mf;                    //Equivalent mass evaporation in KJ/Kg of coal
hs=(R/me)+hfw;               //In KJ/Kg
Tsup=((hs-hg)/Cps)+Ts;       //Enthalpy of superheated steam in degree celsius



//Output
printf('Equivalent evaporation=%f KJ/Kg of coal \n',R);
printf('Boiler efficiency=%f percent \n',etaboiler);
printf('Equivalent mass evaporation= %f KJ/Kg of coal \n',me);
printf('hs=%f KJ/Kg \n',hs);
printf('Enthalpy of superheated steam=%f degree celsius \n',Tsup);
```

Scilab code Exa 11.8 Equivalent mass evaporation

```
///Chapter No 11 Steam Boilers
////Example 11.8 Page No 236
///Find Equivalent mass evaporation
//Input data
clc;
clear;
```

```
ms=6000;                                  //Steam generated in Kg/h
mf=700;                                   //Coal burnt in Kg/h
CV=31500;                                 //Cv of coal in KJ/Kg
x=0.92;                                   //Dryness in fraction of steam
P=12;                                     //Boiler pressure in bar
Tsup=259;                                 //Temperature of steam in degree celsius
Tw=45;                                    //Hot well temperature in degree celsius

//Calculation
hfw=188.35;                               //In KJ/Kg
Ts=187.96;                                //In degree celsius
hf=798.43;                                //In KJ/Kg
hfg=1984.3;                               //In KJ/Kg
hg=2782.7;                                //In KJ/Kg
Cps=2.3;
me=ms/mf;                                 //Equivalent mass evaporation
hs=hf+x*hfg;                              //Enthalpy of wet steam in KJ/Kg
E=((me*(hs-hfw))/2257);                   //Equivalent evaporation in Kg/Kg of coal
hs1=(hg+Cps*(Tsup-Ts));                  //Enthalpy of superheated steam in KJ/Kg
E1=((me*(hs1-hfw))/2257);                 //Equivalent evaporation(with superheater) in Kg/Kg of coal
etaboiler=((me*(hs-hfw))/CV)*100;         //Boiler efficiency without superheater in %
etaboiler1=((me*(hs1-hfw))/CV)*100;//Boiler efficiency with superheater in %

```

```

//Output
printf('Equivalent mass evaporation=%f \n',me);
printf('Enthalpy of wet steam=%f KJ/Kg \n',hs);
printf('Equivalent evaporation=%f Kg/Kg of coal\n',E);
printf('Enthalpy of superheated steam=%f KJ/Kg \n',hs1);
printf('Equivalent evaporation(with superheater)=%f Kg/Kg of coal\n',E1);
printf('Boiler efficiency without superheater=%f percent \n',etaboiler);
printf('Boiler efficiency without superheater=%f percent \n',etaboiler1);
```

Scilab code Exa 11.9 `Mass of steam consumption`

```
///Chapter No 11 Steam Boilers
////Example 11.9 Page No 237
///Find Mass of steam consumption
///Input data
clc;
clear;
P=15;                          //Boiler produces steam in bar
Tsup=250;                      //Boiler temperature in degree celsius
Tw=35;                         //Feed water in degree celsius
MWh=1.5;                       //steam supplied to the turbine
CV=32000;                      //Coal of calorific value in KJ/Kg
etaboiler=80/100;              //Thermal efficiency in %
```

```
fr=210;                         //Firing rate in Kg/m^2/h
//From steam table(temp basis at 35 degree celsius)
hfw=146.56;                     //In KJ/Kg
Ts=198.29;                      //In degree celsius
hfg=1945.2;                     //In KJ/Kg
hg=2789.9;                      //In KJ/Kg
Cps=2.3;


//calculator
hs=hg+Cps*(Tsup-Ts);             //Enthalpy of superheated steam(with superheater) in KJ/Kg
ms=9000/MWh;                     //Steam rate in Kg/MWh
mf=((ms*(hs-hfw))/(etaboiler*CV)); //Mass of steam consumption in Kg/h
GA=mf/fr;                        //Grate rate in m^2



//Output
printf('Enthalpy of superheated steam(with superheater)=%f KJ/Kg \n',hs);
printf('Steam rate= %f Kg/h \n',ms);
printf('Mass of steam consumption=%f Kg/h \n',mf);
printf('Grate rate=%f m^2 \n',GA);
```

Scilab code Exa 11.10 Draught produce in terms of water

```
///Chapter No 11 Steam Boilers
////Example 11.10 Page No 242
//Find Draught produce in terms of water
```

```
//Input data
clc;
clear;
ma=18;              //Boileruses of per Kg of fuel in Kg/Kg
hw=25*10^-3;        //Chimney height to produce draught in mm
Tg=315+273;         //Temperature of chimney gases in degree celsius
Ta=27+273;          //Out side air temp in degree celsius

//Calculation
//Draught produce in terms of water column in m
H=(hw/(353*(1/Ta-1/Tg*((ma+1)/ma))))*1000;

//Output
printf('Draught produce in terms of water column=%f m \n',H);
```

Scilab code Exa 11.11 Draught produce in terms of hot gas

```
///Chapter No 11 Steam Boilers
////Example 11.11 Page No 242
///Find Draught produce in terms of hot gas
//Input data
clc;
clear;
H=40;                              //High discharge in m
ma=19;                             //Fuel gases per Kg of fuel burnt
Tg=220+273;                        //Average temp of fuel gases in degree celsius
Ta=25+273;                         //Ambient
```

```
temperature in degreee celsius


//Calculation
hw=353*H*(1/Ta-1/Tg*((ma+1)/ma)); //Draught produce in terms of water column in mm
H1=H*((Tg/Ta)*(ma/(ma+1))-1);     //Draught produce in terms of hot gas column in m

//Output
printf('Draught produce in terms of water column=%f mm \n',hw);
printf('Draught produce in terms of hot gas column=%f m \n',H1);
```

Scilab code Exa 11.12 Mean temperature of fuel gases

```
///Chapter No 11 Steam Boilers
////Example 11.12 Page No 243
///Find Mean temperature of fuel gases
//Input data
clc;
clear;
H=27;                                    //Chimney height in m
hw=15;                                  //Draught produces of water column in mm
ma=21;                                   //Gases formed per Kg of fuel burnt in Kg/Kg
Ta=25+273;                               //Temperature of the ambient air in degree celsius


//Calculation
Tg=-(((ma+1)/ma)/((hw/(353*H))-(1/Ta))) //Mean
```

```
    temperature of fuel gases in K

//Output
printf('Mean temperature of fuel gases= %f K \n',Tg)
    ;
```

Scilab code Exa 11.13 Air fuel ratio

```
///Chapter No 11 Steam Boilers
////Example 11.13 Page No 244
//Find Air-fuel ratio
//Input data
clc;
clear;
hw=20;                      //Static draught of water
    in mm
H=50;                       //Chimney height in m
Tg=212+273;                 //Temperature of the fuel
    degree celsius
Ta=27+273;                  //Atmospheric air in degree
     celsius

//Calculation
ma=(-((hw/(353*H))-Ta*Tg))*10^-4    //Air-fuel ratio
    in Kg/Kg of fuel burnt-3

//Output
printf('Air-fuel ratio=  %f Kg/Kg of fuel burnt \n',
    ma);
```

Scilab code Exa 11.14 Theoretical draught in millimeters of water

```
///Chapter No 11 Steam Boilers
```

```
////Example 11.14 Page No 245
///Find Theoretical draught in millimeters of water
//Input data
clc;
clear;
H=24;               //Chimney height in m
Ta=25+273;          //Ambient temperature in degree celsius
Tg=300+273;         //Temperature of fuel gases in degree celsius
ma=20;              //Combustion space of fuel burnt in Kg/Kgof fuel
g=9.81;


//Calculation
hw=((353*H)*((1/Ta)-((1/Tg)*((ma+1)/ma))));// Theoretical draught in millimeters of water in mm
H1=H*((Tg/Ta)*(ma/(ma+1))-1);                    // Theoretical draught produced in hot gas column in m
H2=H1-9.975;                                     //Draught lost in friction at the grate and passage in m
V=round(sqrt(2*g*H2));                             // Actual draught produced in hot gas column in m

///Output
printf('Theoretical draught in millimeters of water= %f mm \n',hw);
printf('Theoretical draught produced in hot gas column=%f m \n',H1);
printf('Draught lost in friction at the grate and passage=%f m \n',H2);
printf('Actual draught produced in hot gas column= %f m \n ',V);
```

Scilab code Exa 11.15 Draught lost in friction at the grate and pasage

```
///Chapter No 11 Steam Boilers
////Example 11.15 Page No 246
////Find Draught lost in friction at the grate and pasage
//Input data
clc;
clear;
H=38;                              //Stack height in m
d=1.8;                             //Stack diameter discharge in m
ma=17;                             //Fuel gases per Kg of fuel burnt Kg/Kg
Tg=277+273;                        //Average temperature of fuel gases in degree celsius
Ta=27+273;                         //Temperature of outside air in degree celsius
h1=0.4;                            //Theoretical draught is lost in friction in
g=9.81;
pi=3.142;

//Calculation
H1=H*(((Tg/Ta)*(ma/(ma+1))-1)); //Theoretical draught produce in hot gas column in m
gp=0.45*27.8;                      //Draught lost in friction at the grate and pasage in m
C=H1-gp;                           //Actual draught produce in hot gas column in m
V=sqrt(2*9.81*C);                 //Velocity of the flue gases in the chimney in m/s
rhog=((353*(ma+1))/(ma*Tg));      //Density of flue gases in Kg/m^3
```

```
mg=round(rhog*((pi/4)*(d**(2))*V)); //Mass of gas
    flowing through the chimney in Kg/s


///Output
printf('Theoretical draught produce in hot gas
    column=%f m \n',H1);
printf('Draught lost in friction at the grate and
    pasage=%f m \n',gp);
printf('Actual draught produce in hot gas column=%f
    m \n ',C);
printf('Velocity of the flue gases in the chimney =
    %f m/s \n',V);
printf('Density of flue gases=%f Kg/m^3 \n',rhog);
printf('Mass of gas flowing through the chimney=%f
    Kg/s \n',mg);
```

Scilab code Exa 11.16 Theoretical draught produced in water

```
///Chapter No 11 Steam Boilers
////Example 11.16 Page No 247
///Find Theoretical draught produced in water
//Input data
clc;
clear;
hw=1.9;            //Drauhgt water in cm
Tg=290+273;        //Temp of flue gases in degree
    celsius
Ta=20+273;         //Ambient temp in degree celsius
ma=22;             //Flue gases formed in kg/Kg of
    coal
d=1.8;             //Fuel burnt in m
pi=3.142;
g=9.81;

```

```
//Calculation
H=(hw/(353*(1/Ta-1/Tg*((ma+1)/ma))))*10; //
    Theoretical draught produced in water column in m
H1=round(H*(((Tg/Ta)*(ma/(ma+1))-1)));           //
    Theoretical draught produced in hot gas column n
   m
V=sqrt(2*g*H1);                        //Velocity of
    tthe flue gases in the chimney in m/s
rhog=((353*(ma+1))/(ma*Tg));               //Density
    of flue gases in Kg/m^3
mg=rhog*((pi/4)*d^2)*V;                    //Mass of
    gas flowing through the chimney in Kg/s

//Output
printf('Theoretical draught produced in water column
   = %f m \n ',H);
printf('Theoretical draught produced in hot gas
   column= %f m \n',H1);
printf('Velocity of tthe flue gases in the chimney=
   %f m \n',V);
printf('Density  of flue gases=%f Kg/m^3 \n',rhog);
printf('Mass of gas flowing through the chimney= %f
   Kg/s \n',mg);
```

Scilab code Exa 11.17 `Actual draught produced in hot gas`

```
///Chapter No 11 Steam Boilers
////Example 11.17 Page No 248
///Find Actual draught produced in hot gas
//Input data
clc;
clear;
mf1=8000;           //Average coal consumption in Kg
    /h
ma1=19;            //Flue gases formed in Kg/Kg
```

```
Tg1=270+273;        //Average temperature of the chimney in degree celsius
Ta1=27+273;         //Ambient temperature in degree celsius
hw1=18;             //Theoretical draught produced by the chimney in mm
h11=0.6;            //Draught is lost in friction H1
g1=9.81;
pi1=3.142;


//Calculation
H2=(hw1/(353*(1/Ta1-1/Tg1*((ma1+1)/ma1)))); //Theoretical draught produced in water column in m
H3=H2*(((Tg1/Ta1)*(ma1/(ma1+1)))-1);        //Theoretical draught produced in hot gas column in m
gp1=h11*H3;                                 //Draught is lost in friction at the grate and passing in m
hgc1=H3-gp1;                                //Actual draught produced in hot gas column in m
V1=sqrt(2*g1*(hgc1));                        //Velocity of the flue gases in the chimney in m/s
rhog1=((353*(ma1+1))/(ma1*Tg1));             //Density of flue gases in Kg/m^3
mg1=((mf1/3600)*ma1);                        //Mass of gas fowing throgh the chimney in Kg/s
d1=sqrt(mg1/(rhog1*(pi1/4)*V1));            //Diameter of the chimney in m


//Output
printf('Theoretical draught produced in water column =%f m \n',H2);
printf('Theoretical draught produced in hot gas column=%f m \n',H3);
printf('Draught is lost in friction at the grate and passing=%f m \n',gp1);
```

```
printf('Actual draught produced in hot gas column=%f
    m \n ',hgc1);
printf('Velocity of the flue gases in the chimney=%f
    \n',V1);
printf('Density of flue gases=%f Kg/m^3 \n',rhog1);
printf('Mass of gas fowing throgh the chimney=%f Kg/
    s \n',mg1);
printf('Diameter of the chimney=%f m \n',d1);
```

Scilab code Exa 11.18 Actual draught produced in hot gas

```
///Chapter No 11 Steam Boilers
////Example 11.18 Page No 251
///Find Actual draught produced in hot gas
//Input data
clc;
clear;
H2=24;                    //Chimney height in m
Ta1=25+273;               //Ambient temperature in
    degree celsius
Tg1=300+273;              //Temp of flue gases passing
    through the chimney in degree celsius
ma1=20;                   //Combustion space of fuel
    burnt in Kg/kg of fuel
g1=9.81;

//Calculation
hw1=((353*H2)*((1/Ta1)-((1/Tg1)*((ma1+1)/ma1)))); //
    Theoretical draught produced in water column in m
                                                  //
                                                     Calculation

                                                     mistake

                                                     in
```

```
book of hw1 it is correct according to data & calculation
H3=H2*(((Tg1/Ta1)*(ma1/(ma1+1))-1));             //Theoretical draught produced in hot gas column in m
H4=0.5*H3;                                        //Draught is lost in friction at the grate and passing in m
hgc1=H3-H4;                                       //Actual draught produced in hot gas column in m
V1=sqrt(2*g1*H4);                                //Velocity of the flue gases in the chimney in m/s


//Output
printf('Theoretical draught produced in water column =%f m \n',hw1);
printf('Theoretical draught produced in hot gas
```

```
column= %f m \n',H3);
printf('Draught is lost in friction at the grate and passing=%f m \n ',H4);
printf('Actual draught produced in hot gas column= %f m \n',hgc1);
printf('Velocity of the flue gases in the chimney= %f m/s \n',V1);
```

Scilab code Exa 11.19 `Velocity of the flue gases in the chimney`

```
///Chapter No 11 Steam Boilers
////Example 11.19 Page No 252
///Find Velocity of the flue gases in the chimney
//Input data
clc;
clear;
H2=38;                  //Stack height in m
d1=1.8;                 //Stack diameter in m
ma1=18;                 //Flue gases per kg of the fuel burnt
Tg1=277+273;            //Average temp of the flue gases in degree celsius
Ta1=27+273;             //Temperature of outside air in degree celsius
h11=0.4;                //Theorical draught is lost in friction in %
g1=9.81;
pi1=3.142

//Calculation
H3=H2*(((Tg1/Ta1)*(ma1/(ma1+1))-1)); //Theoretical draught produced in hot gas column in m
gp1=0.40*H3;                          //Draught is lost in friction at the grate and passing in m
hgc1=H3-gp1;                          //Actual draught
```

```
produced in hot gas column in m
V1=sqrt(2*g1*hgc1);                    //Velocity of the flue gases in the chimney in m/s
rhog1=((353*(ma1+1))/(ma1*Tg1));     //Density of flue gases in Kg/m^3
mg1=rhog1*((pi1/4)*d1^2)*V1;          //Mass of gas fowing throgh the chimney in Kg/s


//Output
printf('Theoretical draught produced in hot gas column= %f m \n',H3);
printf('Draught is lost in friction at the grate and passing= %f m \n',gp1);
printf('Actual draught produced in hot gas column=%f m \n',hgc1);
printf('Velocity of the flue gases in the chimney=%f m/s \n',V1);
printf('Density of flue gases=%f Kg/m^3 \n',rhog1);
printf('Mass of gas fowing throgh the chimney=%f Kg/s \n',mg1);
```

Scilab code Exa 11.20 Density of flue gases

```
///Chapter No 11 Steam Boilers
////Example 11.20 Page No 253
////Find Density of flue gases
//Input data
clc;
clear;
hw1=19;             //Draught produced water in cm
Tg1=290+273;        //Temperature of flue gases in degree celsius
Ta1=20+273;         //Ambient temperature  in degree celsius
```

```
ma1=22;              //Flue gases formed  per kg of fuel burnt in kg/kg of coal
d1=1.8;              //Diameter of chimney
g1=9.81;
pi1=3.142


//Calculation
H2=(hw1/((353)*((1/Ta1)-((1/Tg1)*((ma1+1)/ma1)))));    //Theoretical draught produced in hot gas column in m
H3=round(H2*(((Tg1/Ta1)*(ma1/(ma1+1))-1)));                  //Draught is lost in friction at the grate and passing in m
V1=(sqrt(2*g1*H3));                                   //Velocity of the flue gases in the chimney in m/s
rhog1=((353*(ma1+1))/(ma1*Tg1));                          //Density of flue gases in Kg/m**3
mg1=rhog1*((pi1/4)*d1^2)*V1;                              //Mass of gas fowing throgh the chimney in Kg/s


//Output
printf('Theoretical draught produced in hot gas column= %f m \n',H2);
printf('Draught is lost in friction at the grate and passing=%f m \n',H3);
printf('Velocity of the flue gases in the chimney= %f m/s \n',V1);
printf('Density of flue gases=%f Kg/m^2 \n',rhog1);
printf('Mass of gas fowing throgh the chimney= %f Kg/s \n',mg1);
```

Scilab code Exa 11.21 Mass of gas fowing throgh the chimney

```
///Chapter No 11 Steam Boilers
////Example 11.21 Page No 254
///Find Mass of gas fowing throgh the chimney
//Input data
clc;
clear;
mf=8000;                  //Average coal consumption in m
ma=18;                    //Fuel gases formed ccoal fired in m
Tg=270+273;               //Average temp of the chimney of water in degree celsius
Ta=27+273;                //Ambient temp in degree celsius
hw=18;                    //Theoretical draught produced by the chimney in mm
h1=0.6;                   //Draught is lost in friction in H1
g=9.81;
pi=3.142;


//Calculation
H=(hw/((353)*((1/Ta)-((1/Tg)*((ma+1)/ma))))); //Theoretical draught produced in water column in m
H1=H*(((Tg/Ta)*(ma/(ma+1))-1));               //Theoretical draught produced in hot gas column in m
gp=0.6*H1;                                    //Draught is lost in friction at the grate and passing in m
hgc=H1-gp;                                    //Actual draught produced in hot gas column in m
V=sqrt(2*g*hgc);                              //Velocity of the flue gases in the chimney in m/s
rhog=((353*(ma+1))/(ma*Tg));                  //Density of flue gases in Kg/m^3
mg=mf/3600*(ma+1);                            //Mass
```

```
of gas fowing throgh the chimney in Kg/s
d=sqrt(mg/(rhog*(pi/4)*V));                    //Diameter of flue gases in Kg/m^3

///Output
printf('Theoretical draught produced in water column = %f m \n ',H);
printf('Theoretical draught produced in hot gas column= %f m \n',H1);
printf('Draught is lost in friction at the grate and passing= %f m \n',gp);
printf('Actual draught produced in hot gas column= %f \n',hgc);
printf('Velocity of the flue gases in the chimney= %f m/s \n',V);
printf('Density of flue gases= %f Kg/m^3 \n ',rhog);
printf('Mass of gas fowing throgh the chimney= %f Kg/s \n ',mg);
printf('Diameter of flue gases= %f Kg/m^3 \n ',d);
```

Scilab code Exa 11.22 Efficeincy of chimney draught

```
///Chapter No 11 Steam Boilers
////Example 11.22 Page No 256
///Find Efficeincy of chimney draught
///Input data
clc;
clear;
H=45;              //Chimney height in m
Tg=370+273;        //Temperature of flue gases in degree celsius
T1=150+273;        //Temperature of flue gases in degree celsius
ma=25;             //Mass of the flue gas formed in Kg/kg of a cosl fired
```

```
Ta=35+273;      //The boiler temperature in degree
   celsius
Cp=1.004;       //fuel gas

//Calculation
//Efficeincy of chimney draught in %
A=(H*(((Tg/Ta)*(ma/(ma+1)))-1))/(Cp*(Tg-T1))*100;

//Output
printf('Efficeincy of chimney draught= %f percent \n
   ',A);
```

Chapter 13

Steam Engines

Scilab code Exa 13.1 Therotical mean effective pressure

```
////Chapter 13  Steam Engines
////Example 13.1 Page No 281
///Find Therotical mean effective pressure
//Input data
clc;
clear;
Pa=10;                              //Single cylinder
   double acting steam engine pressure in bar
Pb=1.5;                             //Single cylinder
   double acting steam engine pressure in bar
rc=100/35;                          //Cut-off of the
   stroke in %


//Calculation
Pm=((Pa/rc)*(1+log(rc))-Pb); //Therotical mean
   effective pressure

//Output
printf('Therotical mean effective pressure= %f bar \
   n',Pm);
```

Scilab code Exa 13.2 Therotical mean effective pressure

```
////Chapter 13  Steam Engines
////Example 13.2 Page No 283
///Find Therotical mean effective pressure
//Input data
clc;
clear;
a=5/100;       //Engine cylinder of the stroke valume
   in %
P1=12;         //Pressure of the stream
rc=3;          //Cut-off is one-third
Pb=1.1;        //Constant the back pressure in bar

//Calulation
//Therotical mean effective pressure Pm
Pm=P1*(1/rc+((1/rc)+a)*log((1+a)/((1/rc)+a)))-Pb;

//Output
printf('Therotical mean effective pressure=%f N/m^2
   \n',Pm);
```

Scilab code Exa 13.3 Mean Effective pressure

```
////Chapter 13  Steam Engines
////Example 13.2 Page No 285
///Find Mean Effective pressure
///Input data
clc;
clear;
P1=14;              //Steam is ssupplied in bar
```

```
P6=6;              //Pressure at the end in bar
Pb=1.2;            //Pressure at back in bar
a=0.1;
re=4;
//From hyperbolic process
b=0.4;

///Calculation
//Mean Effective pressure in N/m^2
Pm=P1*((1/re)+((1/re)+a)*log((1+a)/((1+re)+a)))-Pb
   *((1+b)+(a+b)*log((a+b)/a));


//Output
printf('Mean Effective pressure= %f N/m^2 \n',-Pm);
```

Scilab code Exa 13.4 Cover end mean effective pressure

```
////Chapter 13  Steam Engines
////Example 13.2 Page No 285
///Find Cover end mean effective pressure
//Input data
clc;
clear;
Cover=1200;                        //Area of the
   indicator diagram for cover
Crank=1100;                        //Area of the
   indicator diagram for crank
ID=75;
PS=0.15;


///Calculation
CoverMEP=Cover/ID*PS;              //Cover end mean
   effective pressure
```

```
CrankMEP=Crank/ID*PS;                //Crank end mean
    effective pressure
AverageMEP=(CoverMEP+CrankMEP)/2; //Average end mean
     effective pressure


///Output
printf('Cover end mean effective pressure= %f bar \n
    ',CoverMEP);
printf('Crank end mean effective pressure= %f bar \n
    ',CrankMEP);
printf('Average end mean effective pressure= %f bar
    \n',AverageMEP);
```

Scilab code Exa 13.5 Mean effective pressure

```
////Chapter 13  Steam Engines
////Example 13.5 Page No 286
///Find Mean effective pressure
//Input data
clc;
clear;
a=25;                    //Area of indicator diagram
    cm^2
Vs=0.15;                 //swept volume m^2
S=1;                     //Scale in cm
cm=0.02;                 //pressure axis m^3


///Calculation
b=Vs/cm;                 //Base length of diagram
Pm=a/b*S;                //Mean effective pressure

//Output
printf('Base length of diagram=%f bar \n',b);
```

```
printf('Mean effective pressure= %f bar \n',Pm);
```

Scilab code Exa 13.6 Therotical mean effective pressure

```
////Chapter 13  Steam Engines
////Example 13.6 Page No 287
///Find Therotical mean effective pressure
//Input data
clc;
clear;
P1=14;                                //Steam Engine
   pressure in bar
Pb=0.15;                              //Back pressure in
    bar
K=0.72;                               //Diagram factor
rc=100/20;

//Calculation
Pm=((P1/rc)*(1+log(rc))-Pb); //Therotical mean
   effective pressure Pm
Pma=Pm*K;                             //Actual mean
   effective pressure Pma

//Output
printf('Therotical mean effective pressure= %f bar \
   n',Pm);
printf('Actual mean effective pressure= %f bar \n',
   Pma);
```

Scilab code Exa 13.7 Actual mean effective pressure

```
////Chapter 13  Steam Engines
////Example 13.7 Page No 287
```

```
////Find Actual mean effective pressure
//Input data
clc;
clear;
P1=9;                              //Reciprocating engine
    pressure in bar
Pb=1.5;                            //Back pressure in bar
rc=100/25;                         //Cut-off
K=0.8;                             //Diagram factor

//Calculation
Pm=((P1/rc)*(1+log(rc))-Pb); //Therotical mean
   effective pressure Pm
Pma=Pm*K;                               //Actual mean
   effective pressure Pma

///Output
printf('Therotical mean effective pressure= %f bar \
   n ',Pm);
printf('Actual mean effective pressure= %f bar \n',
   Pma);
```

Scilab code Exa 13.8 `Diagram factor`

```
////Chapter 13  Steam Engines
////Example 13.8 Page No 288
////Find Diagram factor
//Input data
clc;
clear;
P1=10;                       //Inlet pressure
Pb=1;                         //Back pressure
rc=3;                         //Expansion ratio
a=12.1;                       //Area of indicator diagram
b=7.5;                        //Length of indicator
```

```
diagram
S=3;                            //Pressure scale


//Calculation
Pm=round((P1/rc)*(1+log(rc))-Pb ); //Therotical mean effective pressure Pm
Pma=a/b*S;                              //Actual mean effective pressure Pma
K=Pma/Pm;                               //Diagram factor

///Output
printf('Therotical mean effective pressure= %f bar \n',Pm);
printf('Actual mean effective pressure= %f bar \n',Pma);
printf('Diagram factor= %f \n',K);
```

Scilab code Exa 13.9 Indicated power of steam engine

```
////Chapter 13  Steam Engines
////Example 13.9 Page No 289
//Input data
clc;
clear;
D=200*10^-3;                           //Steam engine cylinder in mm
L=300*10^-3;                           //Bore of steam engine cylinder in mm
rc=100/40;                              //Cut-off of the sroke
P1=7;                                   //Admission pressure of steam in bar
Pb=0.38;                                //Exhaust pressure of steam in bar
```

```
K=0.8;                                  //Diagram factor
N=200;                                  //Indicator factor of engine
pi=3.142;                               //Constant value
//Indicated power of the engine  in rpm
A1=pi*(200*10^-3)^2/4;


//Calculation
Pm=((P1/rc)*(1+log(rc))-Pb);   //Therotical mean effective pressure Pm
Pma=round(Pm*K);                                 //Actual mean effective pressure Pma
IP=(2*Pma*L*A1*N/60000)*10^5;        //Indicated power of steam engine in Kw


//Output
printf('Therotical mean effective pressure= %f bar \n ',Pm);
printf('Actual mean effective pressure= %f bar \n',Pma);
printf('Indicated power of steam engine= %f Kw \n',IP);
```

Scilab code Exa 13.10 Indicated power of steam engine

```
////Chapter 13  Steam Engines
////Example 13.10 Page No 290
///Find Indicated power of steam engine
//Input data
clc;
clear;
IP=343;                      //Steam engine develop indicated power in Kw
```

```
N=180;                    //power In rpm
P1=15;                    //Steam supplied i bar
Pb=1.25;                  //Steam is exhausted in bar
rc=100/25;                //Cut-off take place of
   stroke
K=0.78;                   //Diagram factor
//x=L/D=4/3
x=4/3;                    //Stroke to bore ratio
pi=3.142;


//Calculation
Pm=((P1/rc)*(1+log(rc))-Pb);     //Therotical mean
   effective pressure Pm
Pma=Pm*K;                                 //Actual mean
   effective pressure Pma
D=(((60000*IP)/(2*(Pma*10^5)*(4/3)*N))/(pi/4))^(1/3)
   ;//Indicated power of steam engine
A=((pi/4)*(D^2));
L=(x)*D;


//Output
printf('Therotical mean effective pressure= %f bar \
   n',Pm);
printf('Actual mean effective pressure=%f bar \n',
   Pma);
printf('Indicated power of steam engine=%f mm \n',D)
   ;
printf('Indicated power of steam engine= %f mm \n',L
   );
```

Scilab code Exa 13.11 Actual mean effective pressure

```
////Chapter 13  Steam Engines
```

```
////Example 13.11 Page No 290
///Find Actual mean effective pressure
//Input data
clc;
clear;
D=240*10^-3;  //Steam engine bor
L=300*10^-3;  //Stroke of engine
N=220;         //Speed of engine 220 in rpm
IP=36;         //Indicated power in Kw
Pb=1.3;        //Exhaust pressure in bar
re=2.5;        //Expansion ratio
K=0.8;         //Diagram factor
pi=3.142
A=((pi/4)*(D^2));



//Calculation
Pma=((IP*60000)/(2*10^5*L*A*N));  //Indicated power of steam engine in bar
Pm=Pma/K;                          //Actual mean effective pressure in bar
P1=((Pm+Pb)*re)/(1+log(re));  //Theoretical mean effective pressure in bar

//Output
printf('Indicated power of steam engine= %f bar \n',Pma);
printf('Actual mean effective pressure= %f bar \n',Pm);
printf('theoretical mean effective pressure= %f bar \n',P1);
```

Scilab code Exa 13.12 Indicated power of steam engine

```
////Chapter 13  Steam Engines
////Example 13.12 Page No 291
///Find Indicated power of steam engine
//Input data
clc;
clear;
D=700*10^-3;                //Steam engine diameter in mm
L=900*10^-3;                //Steam engine diameter in mm
Ip=450;                      //Develop indicated power Kw
N=90;                        //Speed of steam engine in rpm
P2=12;                       //Pressure at cut-off in bar
P1=12;                       //Pressure at cut-off in bar
Pb=1.3;                      //Back pressure in bar
K=0.76;                      //Diameter factor
pi=3.142;
A=((pi/4)*0.7^2);

//Calculation
Pma=(Ip*60000)/(2*10^5*L*A*90); //Indicated power of steam engine in bar
Pm=Pma/K;                           //Theoretical mean effective pressure in bar
//using trial and error method
re=1/0.241;                                    //Expansion ratio
///Output
printf('Indicated power of steam engine= %f bar \n',Pma);
printf('Theoretical mean effective pressure= %f bar \n',Pm);
printf('Expansion ratio= %f \n',re);
```

Scilab code Exa 13.13 Brake Power

```
////Chapter 13  Steam Engines
////Example 13.13 Page No 293
///Find Brake Power
//Input data
clc;
clear;
Db=900*10^-3;       //Diameter of break drum in mm
dr=50*10^-3;        //Diameter of rope in mm
W=105*9.81;          //dead weight on the tight side
   of the rope in Kg
S=7*9.81;            //Spring balance of the rope in
   N
N=240;               //Speed of the engine in rpm
pi=3.142;
//Calculation
T=(W-S)*((Db+dr)/2); //Torque Nm
Bp=2*pi*N*T/60000;   //Brake Power in Kw

//Output
printf('Torque= %f Nm \n',T);
printf('Brake Power= %f Kw \n',Bp);
```

Scilab code Exa 13.14 Mechanical efficiency

```
////Chapter 13  Steam Engines
////Example 13.14 Page No 294
///Example Mechanical efficiency
//Input data
clc;
clear;
```

```
D=300*10^-3;                    //steam engine bor
L=400*10^-3;                    //stroke
Db=1.5;                         //effective brake diameter
W=6.2*10^3;                     //net load on the brake
N=180;                           //speed of engine in rpm
Pma=6.5*10^3;                   //mean effective pressure in bar
pi=3.142;
A=((pi/4)*0.3^2);
dr=0;
S=0;

//Calculation
Ip=((2*Pma*L*A*N)/60000)*100; //Indicated power of steam engine in Kw
T=(W-S)*((Db+dr)/2);           //Torque in Nm
Bp=2*pi*N*T/ 60000;            //Break power Kw
eta=(Bp/Ip)*100;               //Mechanical efficiency in%


//Output
printf('Indicated power of steam engine= %f Kw \n',Ip);
printf('Torque=%f Nm \n',T);
printf('Break power= %f Kw \n ',Bp);
printf('Mechanical efficiency= %f percent \n ',eta);
```

Chapter 14

Air Standard Cycles

Scilab code Exa 14.1 `thermal efficiency of the carnot cycle eta`

```
////Chapter No 14 Air Standard Cycles
////Example 14.1 Page No:302
///Find thermal efficiency of the carnot cycle eta
///Input data
clc;
clear;
Tmax=477+273;          //Temperature limits for the engine 477 degree celcius
Tmin=27+273;           //Temperature limits for the engine 27 degree celcius
wd=150;                //Carnot cycle produce in KJ

//Calculatkion
eta=(1-(Tmin/Tmax)); //Thermal efficiency of the carnot cycle in %
Qs=(wd/eta);           //Added during the process in Kj


//Output
printf('thermal efficiency of the carnot cycle eta=
```

```
%f percent \n',100*eta);
printf('added during the process Qs= %f KJ \n',Qs);
```

Scilab code Exa 14.2 `Engin work on carnot cycle`

```
////Chapter No 14 Air Standard Cycles
////Example 2 Page No:302
///Find Engin work on carnot cycle
//Input data
clc;
clear;
QR=1.5;                    //tau=QS-QR
                           //T=Tmax-Tmin
T=300;                     //temperature limit of the cycle in degree celsius


//Calculation
//QR=1.5*(QS-QR)
QR=(1.5/2.5);              //Engin work on carnot cycle
eta=(1-QR);                //Thermal effeciency
Tmax=round((T/eta)-273.15);     //Maximum temperataure
Tmin=(Tmax-T);             //Minimum temperataure


//Output
printf('Engin work on carnot cycle= %f QS \n',QR);
printf('Thermal effeciency= %f percent \n',100*eta);
printf('Maximum temperataure= %f degree celsius \n ',Tmax);
printf('Minimum temperataure= %f degree celsius \n ',Tmin);
```

Scilab code Exa 14.3 pressure at intermediate salient points

```
////Chapter No 14 Air Standard Cycles
////Example No 14.3 Page No 303
///Find pressure at intermediate salient points
//Input data
clc;
clear;
//Refer figure

T1=300;                    //Carnot engine work in minimum temperature in kelvin
T2=750;                    //Carnot engine work in maximum temperature kelvin
P2=50;                     //pressure of carnot engine N/m^2
P4=1;                      //pressure of carnot engine N/m^2
//Considering air as the working fluid therefore
R=0.287;                   //Air as the working fluid in KJ/Kg K
Cp=1.005;                  //KJ/Kg K
Cv=0.718;                  //KJ/Kg K
K=1.4;
gamma1=1.4;

//Calculation
//T2/T1=(P2/P1)**(gamma1-1)/gamma1;
P1=P2*(T1/T2)^(gamma1/(gamma1-1)); //Pressure at intermediate salient points(1-2) in bar
P3=P4*(T2/T1)**(gamma1/(gamma1-1)); //Pressure at intermediate salient points(3-4) in bar
QS=R*T2*log(P2/P3 );          //Heat supplied and rejected per Kg of air  in KJ/Kg
```

```
QR=R*T1*log(P1/P4 );            //Heat supplied and
    rejected per Kg of air  in KJ/Kg
W=QS-QR;                              //Work done in KJ/
    Kg
eta=(1-(T1/T2));                      //Thermal  of the
    carnot cycle

//Output
printf('pressure at intermediate salient points(1-2)
    = %f bar \n',P1);
printf('pressure at intermediate salient points(3-4)
    = %f bar \n',P3);
printf('heat supplied and rejected per Kg of air
    (2-3)= %f KJ/Kg \n',QS);
printf('heat supplied and rejected per Kg of air
    (4-1)= %f KJ/Kg \n',QR);
printf('work done= %f KJ/Kg \n',W);
printf('thermal  of the carnot cycle= %f percent \n'
    ,100*eta);
```

Scilab code Exa 14.4 Heat supplied process

```
////Chapter No 14  Air Standard Cycles
////Example No 14.4  Page No 304
///Find Heat supplied process
//input data
clc;
clear;
T2=377+273;                     //Carnot cycle
    temperature in bar
P2=20*10^5;                     //Carnot cycle pressure
    in bar
V2=1;
V1=5;
V3=2;
```

```
//Consider air as the working fluid therefore
R=0.287;                          //In KJ/Kg K
Cp=1.005;                         //In KJ/Kg K
Cv=0.718;                         //In KJ/Kg K
K=1.4;
gamma1=1.4;

//Calculation
T1=T2*((V2/V1)^(gamma1-1));                      //Minimum temp in degree celsius
Qs=R*T2*log(V3/V2);                              //Heat supplied process in KJ/Kg
QR=R*T1*log((V1/V2)*(V2/V3)*((T2/T1)^(1/(gamma1-1)))); //Heat Rejected Process in KJ/Kg
etath=(1-(T1/T2))*100;                                  //Thermal Effeiciency of the carnot cycle in %



//Output
printf('Minimum temp= %f degree celsius \n',T1);
printf('Heat supplied process= %f KJ/Kg \n',Qs);
printf('Heat Rejected Process=  %f KJ/Kg \n',QR);
printf('Thermal Effeiciency of the carnot cycle=%f percent \n',etath);
```

Scilab code Exa 14.5 compression ratio

```
////Chapter No 14 Air Standard Cycles
////Example No 14.5 Page No 308
///Find compression ratio
///Input data
clc;
clear;
P1=1;                             //Isentropic
```

```
   Compression in bar
P2=20;                          //Isentropic
   Compression in bar
//Consider air as the working fluid therefore
gamma1=1.4;


//Calculation
r=(P2/P1)**(1/gamma1);           //Isentropic process
eta=100*(1-(1/(r^(gamma1-1))));    //Otto cycle air
   standard effeciency in %


//Output
printf('compression ratio= %f \n ',r);
printf('standard efficiency= %f percent \n',eta);
```

Scilab code Exa 14.6 standard efficiency

```
////Chapter No 14 Air Standard Cycles
////Example No 14.6 Page No 308
///Find standard efficiency
//Input data
clc;
clear;
T1=27+273;                       //Initial temp in
   degree celsius
T2=450+273;                      //Final temp in
   degree celsius
gamma1=1.4;

//Calculation
r=(T2/T1)^(1/(gamma1-1));        //Isentropic process
eta=100*(1-(1/(r^(gamma1-1)))); //Otto cycle air
   standard effeciency in %
```

```
//Output
printf('compression ratio= %f \n ',r);
printf('standard efficiency= %f percent \n',eta);
```

Scilab code Exa 14.7 Swept volume

```
////Chapter No 14 Air Standard Cycles
////Example No 14.7 Page No 309
///Find Swept volume
//Input data
clc;
clear;
D=200*10^-3;                    //Otto cycle cylindrical bore in mm
L=450*10^-3;                    //Otto cycle Stroke in mm
vc=2*10^-3;                     //Clearance volume in mm^3
gamma1=1.4;
pi=3.142;

//Calculation
vs=(pi/4)*(D^2*L);              //Swept volume
r=((vs+vc)/vc);                  //Compression ratio
eta=100*(1-(1/(r**(gamma1-1)))); //Standard efficiency

//Output
printf('Swept volume= %f m^3 \n',vs);
printf('compression ratio= %f \n',r);
printf('standard efficiency= %f percent \n',eta);
```

Scilab code Exa 14.8 `Max temp of cycle`

```
////Chapter No 14 Air Standard Cycles
////Example No 14.8 Page No 309
///Find Max temp of cycle
//Input data
clc;
clear;
P1=0.1*10^6;                    //Otto cycle air
T1=35+273;                       //Otto cycle temp degree celsius
r=9;                             //Compression ratio
Qs=1800;                         //Supplied heat in kJ/kg
v1=9;
v2=1;
R=0.287*10^3;
gamma1=1.4;
Cv=0.718;

//Calculation
T2=(T1*((v1/v2)^(gamma1-1))); //Temperature at point 2 in K
P2=(P1*((v1/v2)^1.4))*10^-6;   //pressure at point 2 in MPa
T3=((Qs/Cv)+(T2));               //Max temp of cycle in degree celsius
P3=(T3/T2*P2);                   //Max pressure of cycle in MPa
eta=100*(1-(1/(r^(gamma1-1))));//Otto cycle thermal efficiency in %
WD=(Qs*eta)*10^-2;              //Work done during the cycle in KJ/Kg
v1=((R*T1)/P1);                  //Char gass equation in m^3/Kg
v2=v1/r;                         //Char gass equation in m^3/Kg
Sv=v1-v2;                        //Swept volume in m^3/
```

```
Kg
Pme=(WD/Sv)*10^-3;                //Mean effective pressure in MPa
alpha=P3/P2;                      //Explosion ratio
Pm=(((P1*r)/((r-1)*(gamma1-1)))*(((r^(gamma1-1))-1)*(alpha-1)))*10^-6;//Mean effective pressure in MPa


//Output
printf('Temperature at point= %f K \n',T2);
printf('pressure at point= %f MPa \n',P2);
printf('Max temp of cycle=  %f K \n',T3);
printf('Max pressure= %f MPa \n',P3);
printf('Otto cycle thermal efficiency= %f percent \n',eta);
printf('Work done during the cycle= %f KJ/Kg \n',WD);
printf('Char gass equation= %f m^3/Kg \n',v1);
printf('Char gass equation=  %f m^3/Kg \n',v2);
printf('Swept volume=  %f m^3/Kg \n',Sv);
printf('Mean effective pressure= %f MPa \n',Pme);
printf('Explosion ratio= %f \n',alpha);
printf('Mean effective pressure= %f MPa \n',Pm);
```

Scilab code Exa 14.9 Work done per Kg of air

```
////Chapter No 14 Air Standard Cycles
////Example No 14.9 Page No 311
///Find Work done per Kg of air
//Input data
clc;
clear;
P1=0.1;                           //Beginning compression in MPa
```

```
T1=40+273;                      //Beginning temp in degree celsius
eta=0.55;                       //Standard effeciency in %
QR=540;                         //Rejected heat in KJ/Kg
r=7.36;                         //Compression ratio
gamma1=1.4;
Cv=0.718;

//Calculation
//eta=(1-(1/(r^(gamma-1))))
QS=(-QR/(eta-1));               //Heat supplied/unit mass in KJ/Kg
WD=QS-QR;                       //Work done per Kg of air in KJ/Kg
T2=T1*(r^(gamma1-1));           //Temp at end of compression in K
P2=P1*((r)^gamma1);             //pressure at point 2 in MPa
T3=(QS/Cv)+T2;                  //max temp of the cycle in K
P3=(T3/T2)*P2;                  //max pressure of the cycle in MPa

//Output
printf('Heat supplied/unit mass= %f KJ/Kg \n',QS);
printf('Work done per Kg of air= %f KJ/Kg \n',WD);
printf('Temp at end of compression= %f K \n ',T2);
printf('pressure at point two= %f MPa \n',P2);
printf('max temp of the cycle= %f K \n',T3);
printf('max pressure of the cycle= %f MPa \n',P3);
```

Scilab code Exa 14.10 `Middle temperature`

```
////Chapter No 14 Air Standard Cycles
```

```
////Example No 14.10 Page No 312
///Find Middle temperature
//Input data
clc;
clear;
T1=300;                                     //Initial temp in K
T3=2500;                                    //Final temp in K
P1=1;                                       //Initial pressure in N/m^2
P3=50;                                      //Final pressure in N/m^2
gamma1=1.4;
Cv=0.718;

//Calculation
r=(P3*T1)/(P1*T3);                          //Compression ratio
eta=(1-(1/r^(gamma1-1)));                   //Standard effeciency in %
T2=T1*((P3/P1)^((gamma1-1)/gamma1));        //Middle temperature in K
Qs=Cv*(T3-T2);                              //Heat supplied in KJ/Kg
WD=eta*Qs;                                  //Work done KJ/Kg

//Output
printf('Compression ratio= %f \n',r);
printf('Standard effeciency= %f percent \n',eta);
printf('Middle temperature= %f K \n',T2);
printf('Heat supplied= %f KJ/Kg \n',Qs);
printf('Work done= %f KJ/Kg \n',WD);
```

Scilab code Exa 14.11 diesel engine air standard efficiency

```
////Chapter No 14 Air Standard Cycles
////Example No 14.11 Page No 316
///Find diesel engine air standard efficiency
//input data
clc;
clear;
r=18;    //compression ratio of diesel engine
K=6;     //cut-off ratio of the stroke in%
rho=2.02;
gamma1=1.4;

///Calculation
//diesel engine air standard efficiency
eta=100*((1-(1/r^(gamma1-1)))*(1/gamma1*(rho^(gamma1
    -1)/(rho-1))));

//Output
printf('diesel engine air standard efficiency %f
    percent \n',eta);
```

Scilab code Exa 14.12 `cut off ratio`

```
////Chapter No 14 Air Standard Cycles
////Example No 14.12 Page No 317
///Find cut-off ratio
//Input Data
clc;
clear;
r=22;                //compression ratio of diesel
    engine r=v1/v2
r1=11;               //expansion ratio r1=v4/v3
gamma1=1.4;
rho=1.4;

//Calculation
```

```
rho=r/r1;            //cut−off ratio
//diesel engine air standard efficiency
eta=100*((1-(1/r^(gamma1-1)))*(1/gamma1*(rho^(gamma1
   -1)/(rho-1))));

//Output
printf('cut−off ratio= %f \n',rho);
printf('diesel engine air standard efficiency= %f
   percent \n',eta);
```

Scilab code Exa 14.13 Compression ratio

```
////Chapter No 14 Air Standard Cycles
////Example No 14.13 Page No 317
///Find Compression ratio
//Input data
clc;
clear;
Vc=10/100;                 //Clearance volume in %
Vs=Vc/0.1;
K=0.05;                    //Cut−off of the strok in
gamma1=1.4;

//Calculation
r=((Vs+Vc)/(Vc));          //Compression ratio
rho=1+K*(r-1);             //Cut−off ratio
//Effeciency in %
eta=(1-(1/r^(gamma1-1))*((1/gamma1)*(((rho^(gamma1))
   -1)/(rho-1))))*100;

//Output
printf('Compression ratio= %f Vs \n',r);
printf('Cut−off ratio= %f \n',rho);
printf('Effeciency= %f \n',eta);
```

Scilab code Exa 14.14 `Air standard efficiency`

```
////Chapter No 14 Air Standard Cycles
////Example No 14.14 Page No 317
///Find air standard efficiency
//Input data
clc;
clear;
T1=50+273;            //Temperature at the beginning of the compression
T2=700+273;           //Temperature at the end of the compression
T3=2000+273;          //Temperature at the beginning of the expansion
gamma1=1.4;

//Calculation
r=((T2/T1)^(1/(gamma1-1))); //Compression ratio
rho=(T3/T2);                //Cut-off ratio
K=((rho-1)/(r-1));          //Also cut-off ratio
//Air standard efficiency
eta=(1-(1/r^(gamma1-1))*((1/gamma1)*(((rho^(gamma1))-1)/(rho-1))))*100;

//Output
printf('compression ratio= %f \n',r);
printf('cut-off ratio= %f \n',rho);
printf('also cut-off ratio= %f \n',K);
printf('air standard efficiency= %f percent',eta);
```

Scilab code Exa 14.15 `Maximum temperatureof the cycle`

```
////Chapter No 14 Air Standard Cycles
////Example No 14.15 Page No 317
///Find maximum temperatureof the cycle
//Input data
clc;
clear;
P1=0.1;                 //Diesel cycle is supplied# with air in MPa
T1=40+273;              //Diesel cycle is supplied with temperature in degree celsius
r=18;                   //Compression ratio
Qs=1500;                //Heat supplied
v1=18;
v2=1;
Cp=1.005;
gamma1=1.4;


//Calculation
T2=T1*((v1/v2)^(gamma1-1)); //For isentropic process the temperature is
P2=P1*((v1/v2)^(gamma1));   //For isentropic process the pressure is
T3=(Qs/Cp)+T2;              //Maximum temperatureof the cycle
rho=T3/T2;                  //Cut-off ratio
//Air standard efficiency
eta=(1-(1/r^(gamma1-1))*((1/gamma1)*(((rho^(gamma1))-1)/(rho-1))))*100;
NWD=(Qs*eta)*10^-2;                     //Net work done

//Output
printf('for isentropic process the temperature= %f K \n',T2);
printf('for isentropic process the pressure= %f MPa \n',P2);
printf('maximum temperatureof the cycle=  %f K \n ',T3);
```

```
printf('cut-off ratio= %f MPa \n',rho);
printf('air standard efficiency= %f percent \n',eta)
    ;
printf('net work done= %f KJ/Kg \n',NWD);
```

Scilab code Exa 14.16 Constant pressure

```
////Chapter No 14 Air Standard Cycles
////Example No 14.16 Page No 317
///Find constant pressure
//Input data
clc;
clear;
r=14;                   //compression ratio of standard
    diesel cycle
P1=1;                   //compression stroke in bar
T1=300;                 //temperature of air in k
T3=2774;                //temperature rises in k
CP=1.005;
v1=14;
v2=1;
gamma1=1.4;
Qs=1921.43;
R=0.287*10^3;


//Calculation
T2=T1*((v1/v2)^(gamma1-1));         //Constant pressure
rho=T3/T2;                          //cut-off ratio
eta=(1-(1/r^(gamma1-1))*((1/gamma1)*(((rho^(gamma1))
    -1)/(rho-1))))*100; //air standard efficiency
HS=(CP*(T3-T2));                    //heat supplied
WD=(Qs*eta)*10^-2;                   //Net work done
v1=(R*T1/P1)*10^-5;                  //characteristics
    gas equation
```

```
v2=(v1/r );                          //characteristics gas equation
Sv=(v1-v2);                          //Swept volume
Pme=(WD/Sv )*10^-2;                  //Mean effective pressur
Pm=((P1*r)/((r-1)*(gamma1-1)))*((gamma1*(r^(gamma1-1)))*(rho-1)-((rho^(gamma1))-1));  // mean effective pressure


//utput
printf('constant pressure= %f K \n',T2);
printf('cut-off ratio= %f \n ',rho);
printf('air standard efficiency= %f percent \n',eta);
printf('heat supplied=  %f KJ/Kg \n',HS);
printf('Net work done= %f KJ/Kg \n',WD);
printf('characteristics gas equation= %f m^3/Kg \n',v1);
printf('characteristics gas equation=%f m^3/Kg \n ',v2);
printf('Swept volume=%f m^3/Kg \n ',Sv);
printf('Mean effective pressure=  %f bar \n',Pme);
printf('Mean effective pressure= %f bar \n ',Pm);
```