Scilab Textbook Companion for Fluid Mechanics by I. A. Khan[1]

Created by
Avik Kumar Das
Fluid Mechanics
Civil Engineering
IIT Bombay
College Teacher
Deepashree Raje
Cross-Checked by
Mukul R. Kulkarni

July 11, 2017

[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: Fluid Mechanics

Author: I. A. Khan

Publisher: Holt Rinehart & Winston, New York

Edition: 1

Year: 1987

ISBN: 0030714737

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

Contents

List of Scilab Codes

Chapter 1

Fluid Properties

Scilab code Exa 1.1 properties of fluid

```
//example 1.1
//page 8
clc; funcprot(0);
//initialization of variable
P=50*144*47.88;//pressure
R=8323/29;
T=273+20;//temperature
rho=P/R/T;
disp(rho,"density (kg/m^3)=");
clear
```

Scilab code Exa 1.2 fluid properties

```
//example1.2
//page 12
clc; funcprot(0);
//initialissation of variable
delP=10^6;//change in pressure
```

```
V=1//volume
Beta=2.2*10^9;
delV=-delP/V/Beta;
perV=-delV*100/V;//percent change
disp(perV,"the percent change in volume (%);");
clear
```

Scilab code Exa 1.3 change in volume

```
//example 1.3
//page 13
clc; funcprot(0);
//initialissation of variable
Beta1=2.28*10^9;
Beta2=2.94*10^9;
Beta_av=Beta1/2+Beta2/2;
delP=1034-103.4;
V=10;
delV=-delP/Beta_av*V;
disp(-delV,"net reduction of volume(m^3)=");
clear
```

Scilab code Exa 1.4 change in volume

```
//example 1.4
//page 14
clc; funcprot(0);
//initialisation of variable
delP=102-100;
Beta1=102+14.6;
Beta2=100+14.6;
Beta_av=Beta1/2+Beta2/2;
V=1;
```

```
delV=-delP*V/Beta_av;
disp(-delV,"increase in volume(ft^3)=");
clear
```

Scilab code Exa 1.5 viscosity

```
//example 1.5
//page 14
clc; funcprot(0);
//initialisation of variable
T=68+460;//degree R
R=1716;
kappa=1.4//value from table
c=(kappa*T*R)^(0.5);
disp(c,"velocity of sound(ft/s)=");
clear
```

Scilab code Exa 1.6 force on fluid

```
//example 1.6
//page 20
clc; funcprot(0);
//initialisation of variable
mu=0.09//viscosity
U=1;//velocity
Y=1/1000;//clearence
L=0.2;
d=0.05;
pi=3.14;
sigma=mu*U/Y;//stress
A=pi*d*L;
F=A*sigma;
disp(F,"Force applied (N)=");
```

```
clear
```

Scilab code Exa 1.7 force on fluid

```
//example 1.7
//page 21
clc; funcprot(0);
//initialisation of variable
//part1
y=poly([0 0.01 -1],'x','coeff');
z=roots(y);
disp(z(1),"distance between walls (m)");
//part2
mu=1.005/1000;//viscosity
sigma=-mu*10*(0.01-2*z(1));
disp(sigma,"shear stress on the wall(N/m^2)=");
//part3
y=20*10^-6;
sigma=mu*10*(0.01-2*y);
disp(sigma,"shear stress on the wall(N/m^2)=");
//part4
y=0.01/2;
disp(y,"distance at which stress becomes zero(m)=");
//part5
y=0.01/2;
disp(y,"distance at which velocity is maximum(m)=");
clear
```

Scilab code Exa 1.8 torque

```
//example 1.8
//page 24
clc; funcprot(0);
```

```
//initialisation of variable
R1=0.05;//radius 1
R2=0.05+0.00002;//radius 2
L=0.2;
N=30/60;//omega
t=R2-R1;
pi=3.14;
mu=0.44;//viscosity
//part1
U=pi*N*0.1;
T=R1^2*2*pi*U/t*mu*L;//torque
disp(T,"torque applied (Nm)=");
//part2
T=R1*2*pi*mu*L*U/log(R2/R1);
disp(T,"torque applied (Nm)=");
clear
```

Scilab code Exa 1.9 power required

```



//example 1.9
//page 27
clc; funcprot(0);
//initialisation of variable
mu=0.44;
N=300;
t=0.00025;//thickness
R1=0.15;//radius
R2=0.1;//radius
pi=3.14;
T=pi^2*mu*N/60/t*(R1^4-R2^4);
P=T*2*pi*N/60
disp(P,"power lost in (watts)");
```

```
clear
```

Scilab code Exa 1.10 surface tension

```

//example 1.10
//page 29
clc; funcprot(0);
//initialisation of variable
d=0.01;//diameter
sigma=0.073;//from table
delP=4*sigma/d;
disp(delP,"excess pressure in (N/m^2)");
clear
```

Scilab code Exa 1.11 capillary

```
//example 1.11
//page 31
clc; funcprot(0);
//initialisation of variable
sigma=0.022//from table
Gamma=9789//unit weight
S=0.79;//from table
d=2/1000;//diameter
h=4*sigma/Gamma/S/d;
disp(h*1000,"rise of height of alcohol(mm):");
clear
```

Chapter 2

Fluid Statics

Scilab code Exa 2.1 force on piston

```
//example 2.1
//page 45
clc; funcprot(0);
//initialisation of variable
pi=3.14;
Ap=pi*1^2/4;//area of piston
Ar=pi*10^2/4;//area of ram
W=1000;
F=W/Ar*Ap;
disp(F,"force on piston(N)=");
clear
```

Scilab code Exa 2.2 pressure at that point in Kilonewton per meter square

```
//example 2.2
//page 53
clc; funcprot(0);
//initialisation of variable
```

```
Gamma=10070;//unit weight of water
h=1;
P=Gamma*h;
disp(P,"pressure at that point(kN/m^2)=");
clear
```

Scilab code Exa 2.3 pressure at the bottom in Kilonewton per meter square

```
//example 2.3
//page 53
clc; funcprot(0);
//initialisation of variable
Gamma=9.81;
S=0.85;//specific gravity
P1=150;
h1=0.8;//height
h2=2;
P2=P1+Gamma*S*h1;
P3=P2+Gamma*h2;
disp(P3,"pressure at the bottom (kN/m^2)");
clear
```

Scilab code Exa 2.4 height of the mountain

```
//example 2.4
//page 54
clc; funcprot(0);
//initialisation of variable
P0=570;
P1=750;
R=287;
T0=-5+273;//temperature
n=1.2345;
```

```
k=(n-1)/n;
p=1/k;
y=-R*T0/9.81/k*(1-(P1/P0)^(0.19));
disp(y,"height of the mountain(m)=");
clear
```

Scilab code Exa 2.5 pressure

```

//example 2.5
//page 57
clc; funcprot(0);
//initialisation of variable
Gamma=9810;
ha=950*1.5-500*1;
ha=ha/1000;//m of H2O;
Pa=ha*Gamma;
disp(Pa/1000,"Pressure at A (kPa)=");
clear
```

Scilab code Exa 2.6 force required to open the gate

```
//example 2.6
//page 66
clc; funcprot(0);
//initialisation of variable
Gamma=9810;
ybar=5+0.5;
pi=3.14;
theta=90/180*pi;
Ig=pi*1^4/64;//moment of Inertia
A=pi*1^2/4;
F=Gamma*A*ybar;//force
```

```
hbar=ybar+Ig*(sin(theta))^2/A/ybar;//centroid
F1=F*(hbar-5);
disp(F1,"Force required to open the gate (N)");
clear
```

Scilab code Exa 2.7 depth of center of pressure

```
//example 2.7
//page 67
clc; funcprot(0);
//initialisation of variable
A=2;
pi=3.14;
Gamma=9810;
theta=pi/3;
ybar=0.75+sin(pi/3);
Ig=2^3/12;//moment of inertia
//part1
F=Gamma*A*ybar;//force
disp(F,"Total Force (N)=");
//part2
hbar=ybar+Ig*(sin(theta))^2/A/ybar;//centroid
disp(hbar,"depth of center of pressure(m)=");
clear
```

Scilab code Exa 2.8 depth of hydrostatic pressure

```
//example 2.8
//page 68
clc; funcprot(0);
//initialisation of variable
pi=3.14;
theta=pi/6;
```

```
Gamma=9810;
d=6;//diameter
A=pi*d^2/4;//area
Ig=pi*d^4/64;
Pdash=600;//pressure
Fdash=Pdash*A;
ybar=10+2+3*sin(theta);
F=Gamma*A*ybar;//force
hbar=ybar+Ig*(sin(theta))^2/A/ybar;//centroid
Hbar=(F*hbar+Fdash*ybar)/(F+Fdash);
disp(Hbar,"depth of hydrostatic pressure(ft)=");
clear
```

Scilab code Exa 2.10 hydrostatic force

```
//example 2.10
//page 75
clc; funcprot(0);
//initialisation of variable
ybar=4;
pi=3.14;
A=4;
Gamma=62.4;
Ig=4^3/12;
x1=2;
x2=1.7;
hbar=ybar+Ig/A/ybar;
Fv1=2*A*Gamma;
Fv2=pi*A*Gamma;
Fv=Fv1+Fv2;
disp(Fv,"vertical component of Hydrostatic force(lbs
    )=");
xv=(Fv1*x1+Fv2*x2)/(Fv1+Fv2);
disp(xv,"point of application of vertical force(ft)"
    );
```

```
clear
```

Scilab code Exa 2.11 hydrastatic Force

```
//example 2.11
//page 77
clc; funcprot(0);
//initialisation of variable
pi=3.14;
P=50*144;//pressure
Gamma=62.4;//unit weight
A=4*1;//area
Ig=4^3/12;
ybar=115.4+2.5+2;
//part1
Fh=Gamma*A*ybar;
disp(Fh,"Horizontal component of Hydrastatic Force(
    lbs)=");
//part2
hbar=ybar+Ig/A/ybar;
Fv1=Gamma*A*117.9;
Fv2=pi*4^2/4*Gamma;
Fv=Fv1+Fv2;
disp(Fv,"Vertical component of Hydrostatic force (
    lbs)=");
xv=(Fv1*2+Fv2*1.7)/Fv;
disp(xv,"point of application of vertical force(ft)"
    );
clear
```

Scilab code Exa 2.13 depth submerged

```
//example 2.13
```

```
//page 84
clc; funcprot(0);
//initialisation of variable
GammaB=9810*0.9;//unit weight barrage
Gamma=9.81*1.09*1000;//unit weight of liquid
Area=15*4;
Volume=3*Area;
AW=150*1000;//additional weight
W=GammaB*Volume;
TW=AW+W;//total weight
depth=TW/Gamma/Area;
disp(depth,"depth submerged (m)=");
clear
```

Scilab code Exa 2.14 bottom of solid cylinder above ground

```
//example 2.14
//page 85
clc; funcprot(0);
//initialisation of variable
pi=3.14;
g=9.81;
W=0.4;//weight
k=pi*10^2/(pi*(14^2-10^2));//k=x/y
F=W*g;
//on equating F and substitung x=k*y in equation x+y=6.37/100
y=6.37/100/(1+k);
x=k*y;
disp(0.08-x,"bottom of solid cylinder above ground(m):");
clear
```

Scilab code Exa 2.15 riding Moment

```

//example 2.15
//page 86
clc; funcprot(0);
//initialisation of variable
Gamma=9810;
x1=20/100/3;
x2=20/2/100;
theta=atan(4/20);
V=4*20*100/100^3/2;//volume
Fb=Gamma*V;//Force Buoyant
W=Fb-1.5;//total weight
x=(x2-x1)*cos(theta);
M=W*x;
disp(M*100,"Riding Moment (Ncm)=");
clear
```

Scilab code Exa 2.16 metacentric height

```
//example 2.16
//page 90
clc; funcprot(0);
//initialisation of variable
Io=15*4^3/12;//moment of inertia
V=15*4*2.71;
W=1739.2;
GB=3/2-2.71/2;
pi=3.14;
theta=6/180*pi;
//part1
MG=Io/V-GB;
disp(MG,"metacentric height(m)");
//part2
```

```
M=W*MG*sin(theta);;
disp(M,"righting moment(kNm)");
clear
```

Scilab code Exa 2.17 maximum value

```
//example 2.17
//page 90
clc; funcprot(0);
//initialisation of variable
pi=3.14;
ax=2.6;
ay=1.5;
g=9.81;
m=-ax/(ay+g);
//y2=y1-m*6; putting this value in second equation
y1=0.81;
y2=2.19;
x=linspace(0,15,15);
y=-11310*-y2-2600*x;
clf()
plot(y,x);
//from the graph maximum occurs when
x=0;
disp(x,"maximum occurs at that value");
clear
```

Scilab code Exa 2.18 pressure in pound per feet square

```
//example 2.18
//page 90
clc; funcprot(0);
pi=3.14;
```

```
y0=1;
g=32.2;
r0=0.5;//radius
Gamma=62.4;
omega=2*pi*150/60;
//part1
h0=y0+omega^2*r0^2/4/g;
disp(h0,"height of parabloid(ft)=");
//part2
Pmax=Gamma*h0;
disp(Pmax,"maximum pressure(lbs/ft^2)=");
//part3
z=y0-omega^2*r0^2/4/g;
r=0.2;
y=-0.27;
P=Gamma*omega^2/2/g*r^2-Gamma*y;
disp(P,"Pressure(lbs/ft^2)=");
clear
```

Chapter 3

Fluid Kinematics

Scilab code Exa 3.1 mass flow rate

```


//example 3.1
//page 119
clc; funcprot(0);
// Initialization of Variable
rho=997.1;
pi=3.14;
v=15;//velocity
A=pi*0.3^2/4;
Q=v*A;
disp(Q,"discharge in (m^3/s)");
m=rho*Q;
disp(m,"mass flow rate(kg/s)=");
clear
```

Scilab code Exa 3.3 pipe velocity

```
//example 3.3
//page 120
clc; funcprot(0);
// Initialization of Variable
pi=3.14;
Q=integrate('10*r-1000*r^3','r',0,0.1);
V=2*Q/0.1^2;
disp(V,"velocity(m/s)=");
clear
```

Scilab code Exa 3.5 streamline

```
//example 3.5
//page 127
clc; funcprot(0);
// Initialization of Variable
x=2;
y=4;
pi=3.14;
u=4*x;//velocity x
v=-4*y;//velocity y
V=sqroot(u^2+v^2);
theta=180/pi*atan(v/u);
disp(V,"velocity at (2,4)is (m/s)=");
disp(theta,"angle of the velocity with X axis(
    degrees)=");
clear
```

Scilab code Exa 3.6 fluid acceleration

```
//example 3.6
//page 130
clc; funcprot(0);
// Initialization of Variable
pi=3.14;
rho=1000;
m=25;
Al=pi*9^2/4;//area left
Ar=pi*2.5^2/4;//area right
//part1
AA=Al-(Al-Ar)/4;
V=m*10^4/rho/AA;
disp(V,"velocity at the section AA(m/s)");
//part2
X=0.1;
k=367/(63.62-1.468*X)^2;//k=dV/dX
Acx=V*k;
disp(Acx,"convective acceleration(m/s^2)");
clear
```

Scilab code Exa 3.7 rotational flow

```

//example 3.7
//page 142
clc; funcprot(0);
// Initialization of Variable
//solved for a general value
x=1;
y=1;
k1=-2*sin(y)//dv/dx
k2=-x^2*sin(y)//du/dy;
R=k1-k2;
if R~=0 then
disp("flow is rotational");
```

```
end
```

Scilab code Exa 3.8 rotational flow

```

//example 3.8
//page 143
clc; funcprot(0);
// Initialization of Variable
k1=-9//dv/dx;
k2=16//du/dy
R=k1-k2;
if R~=0 then
disp("flow is rotational");
end
```

Scilab code Exa 3.9 continuity

```

//example 3.9
//page 147
clc; funcprot(0);
// Initialization of Variable
//solved for sample values
x=1;
k1=2*x;//du/dx;
k2=2*x//dv/dy
k3=-4*x//dw/dz
R=k1+k2+k3;
if R==0 then
disp("flow satisfies continuity");
end
clear
```

Scilab code Exa 3.10 continuity

```
//example 3.10
//page 149
clc; funcprot(0);
// Initialization of Variable
D1=10;//dia 1
D2=30;//dia 2
V1=30;//velocity 1
pi=3.14;
V2=V1*pi*D1^2/pi/D2^2;
disp(V2,"velocity at larger section(m/s)=");
clear
```

Chapter 4

Fluid Dynamics

Scilab code Exa 4.1 pressure difference

```

//example 4.1
//page 160
clc; funcprot(0);
// Initialization of Variable
Q=0.1;
A2=19.63/10000;
A1=78.54/10000;
z1=6;
z2=0;
g=9.81
Gamma=9810;//specific weight
V1=Q/A1;
V2=Q/A2;
Pdef=Gamma*(V2^2/2/g+z2-z1-V1^2/2/g);
disp(Pdef/1000,"pressure difference between 1 and 2
    (kN/m^2)");
clear
```

Scilab code Exa 4.2 flow rate in litres per second

```

//example 4.2
//page 161
clc; funcprot(0);
// Initialization of Variable
h=2;
d=2.5/100;
g=9.81;
pi=3.14;
Cd=0.65;//coeff of discharge
A=pi*d^2/4;
Q=Cd*A*sqroot(2*g*h);
disp(Q*1000,"flow rate(l/s)=");
clear
```

Scilab code Exa 4.3 flow rate in meter cube per second

```

//example 4.3
//page 162
clc; funcprot(0);
// Initialization of Variable
h1=3;//height
h2=4;//height
b=0.5;//breadth
Cd=0.65
g=9.81;
Q=Cd*2/3*b*sqroot(2*g)*(h2^1.5-h1^1.5);
disp(Q,"flow rate(m^3/s)=");
clear
```

Scilab code Exa 4.4 flow rate in meter cube per second

```

//example 4.4
//page 164
clc; funcprot(0);
// Initialization of Variable
Cd=0.6;
h1=2;//height
h2=2.2;//height
b=1;//breadth
g=9.81;
Q2=Cd*2/3*b*sqroot(2*g)*(h2^1.5-h1^1.5);

A=1*0.3;//area
H=2.2;
Q1=Cd*sqroot(2*g*H)*A;
Q=Q1+Q2;
disp(Q,"flow rate(m^3/s)=");
clear
```

Scilab code Exa 4.5 flow rate in meter cube per second

```

//example 4.5
//page 165
clc; funcprot(0);
// Initialization of Variable
//on solving A1V1=A2V2
k=0.25//V1/V2
pi=3.14;
Cd=0.95;
d=0.02;//diameter
//using bernaulli equation between these points
V2=sqroot(2.1582/(1-k^2));
```

```
Q=Cd*V2*pi*d^2/4;
disp(Q,"flow rate(m^3/s)=");
clear
```

Scilab code Exa 4.6 velocity in feet per second

```

//example 4.6
//page 166
clc; funcprot(0);
// Initialization of Variable
g=32.2;
delx=0.5;
V=sqroot(2*g*delx);
disp(V,"velocity(ft/s)=");
clear
```

Scilab code Exa 4.7 flow rate in litres per second

```

//example 4.7
//page 173
clc; funcprot(0);
// Initialization of Variable
g=9.81
d=0.15;
pi=3.14;
//on solving bernaulli equation
V2=sqroot(2*g*25/4.25);
A=pi*d^2/4;
Q=A*V2;
disp(Q*1000,"flow rate (l/s)=");
clear
```

Scilab code Exa 4.8 power input in kiloWatts

```
//example 4.8
//page 174
clc; funcprot(0);
//initialisation of variable
d1=2/100;
d2=6/100;
pi=3.14;
g=9.81;
V2=40;
effi=0.8;
V1=V2*d1^2/d2^2;
A1=pi*d1^2/4;//area
A2=pi*d2^2/4;//area
Gamma=9810;
P1=-50;
z2=100;
hs=V2^2/2/g-V1^2/2/g-P1/Gamma+z2+30;
Q=A1*V1;
P=Gamma*Q*hs;
Pi=P/effi;
disp(Pi/100,"Power input (kW):");
clear
```

Scilab code Exa 4.9 pressure head

```
//example 4.9
//page 177
```

```
clc; funcprot(0);
//initialisation of variable
za=500;
z1=480;
v1=4.08;
g=9.81;
d=0.25;
l1=100;//length
//part1
k=za-z1-v1^2/2/g-0.02*l1/d*v1^2/2/g;//k=pa/gamma
HGLa=z1+k;
disp(HGLa,"pressure head at A (m)=");
//part2
zb=550;
v2=0;
l2=500;
hs=zb-za+0.02*l2/d*v1^2/2/g;
HGLb=HGLa+hs;
disp(HGLb,"pressure head at B (m)=");
clear
```

Chapter 5

Fluid Momentum

Scilab code Exa 5.1 resultant force

```
//example 5.1
//page 192
clc; funcprot(0);
//initialisation of variable
Q=0.3;//flow rate
D1=0.3;
D2=0.15;
pi=3.14;
rho=1000;
P1=175;
P2=160;
A1=pi*D1^2/4;
A2=pi*D2^2/4;
V1=Q/A1;
V2=Q/A2;
theta=45/180*pi;
F1=P1*A1*1000;
F2=P2*A2*1000;
Rx=F1-F2*cos(theta)-rho*Q*(V2*cos(theta)-V1);
```

```
Ry=F2*sin(theta)+rho*Q*(V2*sin(theta));
R=sqroot(Rx^2+Ry^2);
disp(R,"resultant force(N)");
th=atan(Ry/Rx);
disp(th*180/pi,"angle at which force is applying")
clear
```

Scilab code Exa 5.2 resultant force on vane

```


//example 5.2
//page 194
clc; funcprot(0);
//initialisation of variable
rho=1.94;
V1=80;
g=32.2;
Q=8;
z2=3;//elevation
pi=3.14;
theta=60/180*pi;
V2=sqroot(2*g*(V1^2/2/g-3));
Rx=rho*Q*(V1-V2*cos(theta));
Ry=rho*Q*(V2*sin(theta));
R=sqroot(Rx^2+Ry^2);
disp(R,"resultant force on vane (lbs)");
th=atan(Ry/Rx);
disp(th*180/pi,"angle at which force is applying")
clear
```

Scilab code Exa 5.3 resultant force

```
//example 5.3
//page 194
clc; funcprot(0);
//initialisation of variable
Q1=0.5;//flow
Q2=0.3;//flow
Q3=0.2;//flow
D1=0.45;//diameter
D2=0.3;//diameter
D3=0.15;//diameter
pi=3.14;
g=9.81;
P1=60000;//pressure
th1=30/180*pi;//theta1
th2=20/180*pi//theta2
Gamma=9810;
A1=pi*D1^2/4;
A2=pi*D2^2/4;
A3=pi*D3^2/4;
V1=Q1/A1;
V2=Q2/A2;
V3=Q3/A3;
P2=P1+V1^2/2/g*Gamma-V2^2/2/g*Gamma;
P3=P1+V1^2/2/g*Gamma-V3^2/2/g*Gamma;
F1=P1*A1;
F2=P2*A2;
F3=P3*A3;
Rx=F3*cos(th2)-F2*cos(th1)+1000*(Q2*V2*cos(th1)-Q3*
   V3*cos(th2));
Ry=F3*sin(th2)-F2*sin(th1)+1000*(Q2*V2*sin(th1)+Q3*
   V3*sin(th2)-Q1*V1)-F1;
R=sqroot(Rx^2+Ry^2);
disp(R,"resultant force(N)");
clear
```

Scilab code Exa 5.4 impulse of force

```
//example 5.4
//page 199
clc; funcprot(0);
//initialisation of variable
D=2;
pi=3.14;
V=100;
A=pi*D^2/4/144;
Q=A*V;
Rx=62.4/32.2*Q*V;
disp(Rx,"impulse of force (lbs)");
clear
```

Scilab code Exa 5.5 efficiency

```
//example 5.5
//page 202
clc; funcprot(0);
//initialisation of variable
D=7.5/100;
pi=3.14;
Vp=10;//velocity plate
Gamma=9810;
g=9.81;
V=15;
A=pi*D^2/4;
Q=A*V;
```

```
P=Gamma/g*Q*(V-Vp)*Vp;
disp(P,"work done per s on the plate (Nm/s)");
F=P/Vp;
disp(F,"force applied on the plate(N)");
Effi=2*(V-Vp)*Vp/V^2;
disp(Effi*100,"Efficiency (%)=")
clear
```

Scilab code Exa 5.6 resultant reaction

```

//example 5.6
//page 202
clc; funcprot(0);
//initialisation of variable
D=3;
pi=3.14;
Q=2;
rho=1.94;
A=pi*D^2/4/144;
V=Q/A;
Rx=rho*Q*2*V*3^0.5/2;
Ry=rho*Q*2*(V-V);
R=sqroot(Rx^2+Ry^2);
disp(R,"resultant reaction (lbs)=");
clear
```

Scilab code Exa 5.7 efficiency

```

//example 5.7
//page 204
clc; funcprot(0);
```

```
//initialisation of variable
V1=40;//velocity
Vp=20;//velocity
pi=3.14;
th1=30/180*pi;//angle
th2=20/80*pi;//angle
g=9.81;
th=atan(V1*sin(th1)/(V1*cos(th1)-Vp));
V1r=V1*sin(th1)/sin(th);
V2r=V1r;
//on solving
phi=4/180*pi;
V2=V2r*sin(phi)/sin(th2);
V2w=V2*cos(th2);
W=(V2w+V1*cos(th1))*Vp/g;
disp(W,"work done per N of fluid(Nm)=");
Effi=1-(V2/V1)^2;
disp(Effi*100,"efficiency(%)=");
clear
```

Scilab code Exa 5.8 change in pressure

```

//example 5.8
//page 211
clc; funcprot(0);
//initialisation of variable
pi=3.14;
mdot=0.0022;//mas flow rate
V1=220*5280/3600;//velocity
V=12000/pi/6^2*4;//velocity
V4=2*V-V1;//velocity
//part1
F=mdot*(V4-V1)*12000;
disp(F,"thurst force (lbs)");
```

```
//part2
neta=V1/V*100;
disp(neta,"efficiency (%)");
Hp=F*V1/500/neta*100;
disp(Hp,"theoritical horse power (hp)=");
delP=mdot/2*(V4^2-V1^2);
disp(delP,"change in pressure (lbs/ft^2)=");
clear
```

Chapter 6

Dimensional Analysis

Scilab code Exa 6.1 power of M, L, T

```

//example 6.1
//page 224
clc; funcprot(0);
//initialisation of variable
//part1;
//solving for powers of M,L,T
A=[1 0 0;-3 1 1;0 -1 0];
b=[-1;-1;2];
x=A\b;
disp("in non dimensional term")
disp(x(1),"power of M");
disp(x(2),"power of L");
disp(x(3),"power of T");
//part2
//solving for powers of M,L,T
A=[1 0 0;-3 1 1;0 -1 0];
b=[-1;1;1];
x=A\b;
disp("in non dimensional term")
disp(x(1),"power of M");
```

```
disp(x(2),"power of L");
disp(x(3),"power of T");
clear
```

Scilab code Exa 6.2 velocity of model

```

//example 6.2
//page 233
clc; funcprot(0);
//initialisation of variable
rhom=998.2;//density
rhop=858.45;//density
mum=1.005*10^-3;//viscosity
mup=8/1000;//viscosity
Vp=2.5*10;//velocity
Vm=Vp*rhop*mum/mup/rhom;
disp(Vm,"velocity of model (m/s):");
clear
```

Scilab code Exa 6.3 Head over model

```

//example 6.3
//page 233
clc; funcprot(0);
//initialisation of variable
k=1/50;//lm/lp;
C=3.8;
L=300;
Q=100000;
Qm=Q*k^2.5;
disp(Qm,"flow rate on model(m^3/s)")
```

```
H=(Q/C/L)^(2/3);
disp(H/50,"Head over model(ft)");
clear
```

Chapter 7

Fluid Resistance

Scilab code Exa 7.1 reynolds number of glycerine flow

```

//example 7.1
//page 245
clc; funcprot(0);
//initialisation of variable
mug=8620/10000;//viscosity of glycerine
nuw=0.804*10^-6//kinematic viscosity of water
S=1.26;
rhog=995.7;//density of glycerine
rhow=1000;//density of water
D=0.02;
V=0.3;
Rw=V*D/nuw;
disp(Rw,"reynolds number of water flow");
disp("reynolds number greater than 2000 so flow
    turbulent");
Rg=V*D/mug*rhog;
disp(Rg,"reynolds number of glycerine flow");
disp("reynolds number less than 2000 so flow laminar
    ");
clear
```

Scilab code Exa 7.2 eddy viscosiy

```

//example 7.2
//page 245
clc; funcprot(0);
//initialisation of variable
y=0.3;
sigma=103;//stress
rho=1000;//density
k=0.7/y;//k=du/dy;
kappa=sqroot(sigma/rho/y^2/k^2);
l=kappa*y;
disp(l,"mixing length (m)");
neta=rho*l^2*k;
disp(neta,"eddy viscosiy(Nm/s^2)");
clear
```

Scilab code Exa 7.3 drag force

```

//example 7.3
//page 256
clc; funcprot(0);
//initialisation of variable
U=1;//speed
L=2;//length
rho=1260;//density
mu=0.862;//viscosity
tau=[0 0 0 0 0];
x=[0.1 0.5 1 1.5 2];
```

```
delta=[4.13 9.24 13.07 16.01 18.48];
for i=1:5
    tau(i)=10.94/sqroot(x(i));
end
plot(x,delta);
plot(x,tau,'r');
drag=0.664*sqroot(mu*rho*U^3*L);
disp(drag,"drag force (N)");
clear
```

Scilab code Exa 7.4 drag force

```

//example 7.4
//page 256
clc; funcprot(0);
//initialisation of variable
mu=18.22*10^-6;
L=0.951;
rho=1.197;
U=8;//speed
L2=5;//length
drag=0.664*sqroot(mu*rho*U^3*L)+0.036*rho*U^2*L2*(mu/rho/U/L2)^(0.2)-0.036*rho*U^2*L*(mu/rho/U/L)^(0.2)
disp(drag,"drag force (N)");
clear
```

Scilab code Exa 7.5 drag force

```

//example 7.5
//page 270
```

```
clc; funcprot(0);
//initialisation of variable
S=1.26;
mu=0.862;
rho=1260;
pi=3.14;
Cd=35;
U=0.05;
D=0.01;
Re=rho*U*D/mu;
Fd=1/2*Cd*rho*U^2*pi*D^2/4;
disp(Fd,"drag force (N)");
clear
```

Scilab code Exa 7.6 drag force

```

//example 7.6
//page 272
clc; funcprot(0);
//initialisation of variable
A=50;//area
Cd=0.3;
U=11.11;//speed
rho=1.177;
Fd=1/2*Cd*rho*U^2*A;
disp(Fd,"drag force (N)");
clear
```

Chapter 8

Laminar Flow

Scilab code Exa 8.1 reynolds no.

```
//example 8.1
//page 288
clc; funcprot(0);
//initialisation of variable
L=10;//length
R=0.002;//radius
P1=200;
P2=260;
pi=3.14;
rho=0.81*1000;
mu=19.1/10000;
Sp=-(P1+0.81*6*9.81-P2)/L;//slope of pressue
taumax=R/2*Sp*1000;
disp(taumax,"maximum shear force(N/m^2)");
vmax=R^2/4/mu*Sp*1000;
disp(vmax,"maximum velocity(m/s)");
Q=pi*R^4/8/mu*Sp*1000;
disp(Q,"flow rate (m^3/s)");
R=vmax/2/mu*2*R*rho;
disp(R,"reynolds no.");
```

```
clear
```

Scilab code Exa 8.2 head loss

```

//example 8.2
//page 290
clc; funcprot(0);
//initialisation of variable
nu=1.54*10^-6;
V=0.1;
D=0.02;
g=9.81;
L=30;
Re=V*D/nu;
f=64/Re;
hf=f*L/D*V^2/2/g;
disp(hf,"head loss (m of H20)");
clear
```

Scilab code Exa 8.3 horse power required

```

//example 8.3
//page 290
clc; funcprot(0);
//initialisation of variable
Gamma=0.92*62.4;
nu=0.0205;
d=9/12;
pi=3.14;
g=32.2;
L=5280;//length
```

```
Q=50*2000/Gamma/3600;
A=pi*d^2/4;
V=Q/A;
Re=V*d/nu;
f=64/Re;
hf=f*L/d*V^2/2/g;
Hp=Gamma*Q*hf/550;
disp(Hp,"horse power required ");
clear
```

Scilab code Exa 8.4 viscosity

```

//example 8.4
//page 290
clc; funcprot(0);
//initialisation of variable
T=20*60;//time
L=10;
H1=5;
pi=3.14;

g=9.81*100;
D1=0.1;
A1=pi/4*D1^2;//area
A2=pi/4*5^2;//area
rho=0.88;//density
H2=5-50/A2;//height
mu=T*rho*A1*g/32/A2/L/log(5/2.45)*D1^2;
disp(mu,"viscosity (poise)");
clear
```

Scilab code Exa 8.5 shear stress on the plate

```
//example 8.5
//page 290
clc; funcprot(0);
//initialisation of variable
S=0.81;
mu=4/10^5;
Gamma=62.4*0.81;
P1=6.5*144+Gamma*4/2;
P2=8*144;
Sp=(P1-P2)/4;
q=integrate('2154.75*y-359125*y^2','y',0,0.006);
disp(q,"discharge per unit ft on the plate (ft^2/s)");
k=2154.75-718250*0.006;//k=du/dy
tau=4*10^-5*k;
disp(tau,"shear stress on the plate (lbs/ft^2)");
clear
```

Chapter 9

Turbulent Flow in Pipes

Scilab code Exa 9.1 head loss

```

//example 9.1
//page 308
clc; funcprot(0);
//initialisation of variable
S=1.26;
mu=0.862//N.s/m^2
rhow=998;//density
rhog=1.26*998;//density of glycerine
Q=0.1;
g=9.81;
L=100;
D=0.2;
pi=3.14;
f=0.0688;//coeff of friction
A=pi*0.2^2/4;
V=Q/A;
R=V*D*rhog/mu;
hf=f*L/D*V^2/2/g;
disp(hf,"head loss if glucerine is flowing(m of
    glycerine)");
```

```
//part2
mu=1.005*10^-3;
R=V*D*rhow/mu;
f=0.021;//coeff. of friction
hf=f*L/D*V^2/2/g;
disp(hf,"head loss if water is flowing(m of water)");
clear
```

Scilab code Exa 9.2 flow rate

```

//example 9.2
//page 311
clc; funcprot(0);
//initialisation of variable
L=100;//length
D=0.2;//diameter
hf=5.43;//head loss
g=9.81
pi=3.14;
f=0.021//friction coeff.
A=sqroot(2*g*D*hf/L);//area
V=A/sqroot(f);
Q=V*pi*D^2/4;
disp(Q,"flow rate (m^3/s)=");
clear
```

Scilab code Exa 9.3 diameter of the pipe

```

//example 9.3
//page 311
```

```
clc; funcprot(0);
//initialisation of variable
Q=0.1;
hf=5.43;//head loss
L=100;
nu=1.007*10^-6;//kinematic viscosity
pi=3.14;
g=9.81;
A=8*L*Q^2/hf/g/pi^2;
//using moody's chart
f=0.021;
D=(A*f)^0.2;
disp(D,"diameter of the pipe(m)=");
clear
```

Scilab code Exa 9.4 head loss

```

//example 9.4
//page 318
clc; funcprot(0);
//initialisation of variable
L=500;
S=0.004;//slope of slope line
hf=S*L;
disp(hf,"head loss (ft)=");
clear
```

Scilab code Exa 9.5 head loss

```

//example 9.5
//page 319
```

```
clc; funcprot(0);
//initialisation of variable
epsilon=0.025;//roughness
L=500;
pi=3.14;
g=9.81;
D=30/100;
Q=0.1;
K=pi/4*sqroot(2*g)*(2*log10(D*100/epsilon)+1.14)*D^2.5;
S=(Q/K)^2;
hf=S*L;
disp(hf,"head loss(m)=");
clear
```

Scilab code Exa 9.6 flow rate

```

//example 9.6
//page 319
clc; funcprot(0);
//initialisation of variable
epsilon=0.025;//roughness
L=500;
pi=3.14;
g=9.81;
D=20/100;
Q=0.1;
S=5.43/100;
K=pi/4*sqroot(2*g)*(2*log10(D*100/epsilon)+1.14)*D^2.5;
Q=K*sqroot(S);
disp(Q,"flow rate(m^3/s)=");
clear
```

Scilab code Exa 9.7 diameter

```
//example 9.7
//page 320
clc; funcprot(0);
//initialisation of variable
epsilon=0.025;//roughness
L=500;
pi=3.14;
g=9.81;
Q=0.1;
S=5.43/100;
K=Q/sqroot(S);
//solving for D
deff('y=f(D)','y=3.14/4*sqroot(2*9.81)*(2*log10(D
    /0.025)+1.14)*D^2.5-.3');
[x]=fsolve(0.1,f);
disp(x,"diameter(m):");
clear
```

Scilab code Exa 9.8 total head loss

```
//example 9.8
//page 326
clc; funcprot(0);
//initialisation of variable
Q=0.075;
L=30;
D=0.1;
pi=3.14;
```

```
k=0.5;
K=10;
g=9.81;
nu=1.007*10^-6//kinematic viscosity
A=pi*D^2/4;
V=Q/A;
R=V*D/nu;
//using moody's chart
f=0.025;
hf1=f*L*V^2/2/g/D;//head loss by friction
hf2=k*V^2/2/g;//head loss due to contraction
hf3=K*V^2/2/g;//head loss due to expansion
hf=hf1+hf2+hf3;
disp(hf,"total head loss (m of H2O)=");
clear
```

Scilab code Exa 9.9 flow in pipe

```

//example 9.9
//page 329
clc; funcprot(0);
//initialisation of variable
nu=1.007*10^-6;
g=9.81;
hf=100;
pi=3.14;
//on solving V1 and V2 in terms of V3 and
// iterate for f1 and f2
//we get
f1=0.019;
f2=0.022;
V3=sqroot(2*g*hf/(8.4*f1+268.85*f2+4.85));
Q3=V3*pi*0.08^2/4;
disp(Q3,"flow in pipe 3(m^3/s)=");
```

```
clear
```

Scilab code Exa 9.10 length of pipe

```

//example 9.10
//page 333
clc; funcprot(0);
//initialisation of variable
f1=0.021//friction in pipe 1
d1=0.2;
k=f1*(10+50+30+20+100)/d1^5+2*0.9/d1^4+10/d1
   ^4+2*1.2/d1^4;//k=(HL)1/(16Q^2/2pi^2g)
f2=0.023//friction pipe 2
d2=0.15;
L2=k*d2^5/f2;
disp(L2,"length of pipe2 (m)=")
clear
```

Scilab code Exa 9.11 head loss

```

//example 9.11
//page 3337
clc; funcprot(0);
//initialisation of variable
Q=2;
nu=1.007*10^-56;
d2=0.3;
d1=0.5;
d3=0.15;
L1=500;
L2=200;
```

```
L3=300;
pi=3.14;
g=9.81;
f=0.018//(solved using iteration from moody's chart)
A1=pi*d1^2/4;
A2=pi*d2^2/4;
A3=pi*d3^2/4;
//assumption
q1=0.5;
q2=sqroot(L1*q1^2/d1^5*d2^5/L2);
q3=sqroot(L1*q1^2/d1^5*d3^5/L3);
Q1=2*q1/(q1+q2+q3);
hf=f*L1*Q1^2/A1^2/2/g/d1;
disp(hf,"head loss (m)=");
clear
```

Scilab code Exa 9.12 flow in pipe

```

//example 9.12
//page 340
clc; funcprot(0);
//initialisation of variable
L1=5000;
D1=1.5;
EL1=135;//energy level 1
L2=800;
D2=0.5;
EL2=120;
EL3=112;
L3=1500;
D3=0.75;
//using iteration junction height=131.6;

Q1=sqroot((EL1-131.6)/0.7594);
```

```
disp(Q1,"flow in pipe 1(m^3/s)");
Q2=sqroot((131.6-EL2)/36.33);
disp(Q2,"flow in pipe 2(m^3/s)");
Q3=sqroot((131.6-EL3)/8.168);
disp(Q3,"flow in pipe 3(m^3/s)");
clear
```

Scilab code Exa 9.13 flow in pipe

```

//example 9.13
//page 342
clc; funcprot(0);
//initialisation of variable
L1=5000;
D1=1.5;
EL1=136;//energy level 1
L2=800;
D2=0.5;
EL2=122;
EL3=110;
L3=1500;
D3=0.75;
//using iteration junction height=131;
j=131;
Q1=sqroot((EL1-j)/0.7594);
disp(Q1,"flow in pipe 1(m^3/s)");
Q2=sqroot((j-EL2)/36.33);
disp(Q2,"flow in pipe 2(m^3/s)");
Q3=sqroot((j-EL3)/8.168);
disp(Q3,"flow in pipe 3(m^3/s)");
clear
```

Scilab code Exa 9.14 minimum depth of ridge

```

//example 9.14
//page 349
clc; funcprot(0);
//initialisation of variable
z=100;//elevation
f=0.0125;//using iteration
L=10000;
L2=1000;
D=2;
g=32.2;
pi=3.14;
V=sqrt(2*g*z/f/L*D);
Q=pi*D^2/4*V;
x=34-10-f*L2*V^2/2/g/D-V^2/2/g;
disp(30-x,"minimum depth of ridge(ft)=");
clear
```

Chapter 10

Open Channel Flow

Scilab code Exa 10.1 section factor

```
//example 10.1
//page 363
clc; funcprot(0);
//initialisation of variable
z=0.5//slope
b=3;//breadth
y=2;//height
T=b+2*z*y;//top width
disp(T,"top width(m)=");
A=(b+z*y)*y;//area
disp(A,"area(m^2)=");
P=b+2*y*sqroot(1+z^2);
disp(P,"Perimeter(m)=");
R=A/P;//hydraulic radius
disp(R,"Hydraulic radius(m)=");
D=A/T//hydraulic depth
disp(D,"Hydraulic depth(m)=");
Z=A*D^0.5;
disp(Z,"section factor(m^2.5)=");
clear
```

Scilab code Exa 10.2 flow rate

```
//example 10.2
//page 366
clc; funcprot(0);
//initialisation of variable
z=1;
b=3;
y=1.5;
S=0.0009;
n=0.012;
A=(b+z*y)*y;
P=b+2*y*sqroot(1+z^2);
R=A/P;
Q=A/n*R^(2/3)*S^0.5;
disp(Q,"flow rate (m^3/s)");
clear
```

Scilab code Exa 10.3 height of water

```
//example 10.3
//page 367
clc; funcprot(0);
//initialisation of variable
Q=16.1;
b=3;
z=1;
S=0.0009;
//solving for y;
```

```
deff('y=f(x)','y=(3+x)/0.012*x*((3+x)*x/(3+2.828*x))
    ^(2/3)*0.0009^0.5-16.1');
[x,v,info]=fsolve(1,f);
disp(x,"height of water(ft)=");
clear
```

Scilab code Exa 10.4 width of bottom

```

//example 10.4
//page 372
clc; funcprot(0);
//initialisation of variable
S=1/1600;//slope of channel
Q=10000/60;
//on solving and simplifying
y=(Q/1.828/2.25/sqroot(0.5))^0.4;
b=0.828*y;
disp(b,"width of bottom(ft)=");
clear
```

Scilab code Exa 10.5 critical depth

```

//example 10.5
//page 378
clc; funcprot(0);
//initialisation of variable
Vc=20;//velocity
g=9.81;
yc=(Vc^2/g)^(1/3);
disp(yc,"critical depth(m)=");
clear
```

Scilab code Exa 10.6 critical depth of water

```

//example 10.6
//page 380
clc; funcprot(0);
//initialisation of variable
z=0.5;
S=0.0008;
n=0.025;//manning's constant
Q=15;//flow rate
g=9.81;
//part1
//solving for y
deff('y=f(x)','y=(4+0.5*x)/0.025*x*((4+0.5*x)*x/(4+2.236*x))^(2/3)*0.0008^0.5-15');
[x,v,info]=fsolve(1,f);
disp(x,"normal depth of water(ft)=");
clear
//part2
z=0.5;
S=0.0008;
n=0.025;//manning's constant
Q=15;//flow rate
g=9.81;
b=4;
y=2.22//depth of water
A=(b+z*y)*y;
T=b+2*z*y;
D=A/T;
V=Q/A;
F=V/sqroot(g*D);
disp(F,"Froude Number");
//part3
```

```
deff('y=f(x)','y=(4+0.5*x)*x*((4+0.5*x)*x*9.81/(4+1*
   x))^(1/2)-15');
[x,v,info]=fsolve(1,f);
disp(x,"critical depth of water(ft)=");
clear
```

Scilab code Exa 10.7 Froude Number

```

//example 10.7
//page 382
clc; funcprot(0);
//initialisation of variable
z=0.7;
S=0.0004;
n=0.012;//manning's constant
Q=15;//flow rate
g=9.81;
b=4;
y=2.22//depth of water
A=(b+z*y)*y;
T=b+2*z*y;
D=A/T;
V=Q/A;
F=V/sqroot(g*D);
disp(F,"Froude Number");
clear
```

Scilab code Exa 10.8 total loss of energy

```

//example 10.8
//page 391
```

```
clc; funcprot(0);
//initialisation of variable
b=60;//bottom width
y1=2.5;//depth
g=32.2;
Q=2500;//flow rate
Gamma=62.4//unit weight
V1=Q/b/y1;//velocity
F1=V1/sqroot(g*y1);
k=0.5*(sqroot(1+8*F1^2)-1);//k=y1/y2
y2=k*y1; //depth
V2=Q/b/y2;//velocity
L=y2*4.25;
LE=y2+V2^2/2/g-y1-V1^2/2/g;//loss of energy
TL=Gamma*-LE*2500;
disp(TL,"total loss of energy(ft-lbs/s)");
clear
```

Scilab code Exa 10.9 depth of water

```

//example 10.9
//page 396
clc; funcprot(0);
//initialisation of variable
//solving for y
z=2;//trapezoid ratio
b=10;//base
n=0.012;//coeff
s=0.0002;//slope
Q=180;//discharge
l=5000;//distance
y(1)=10;
A(1)=(b+z*y(1))*y(1);
P(1)=b+2*y(1)*sqroot(1+z^2);
```

```
E(1)=y(1)+0.02;
Rbar(1)=0;
Abar(1)=0
Pbar(1)=0;
distance(1)=0;
delx(1)=0;
S(1)=0;
deff('y=f(x)','y=180^2*(10+4*x)/9.81/x^3/(10+2*x)^3-1');
[x,v,info]=fsolve(1,f);
disp(x,"critical depth of water(ft)=");

//for the table
for i=2:6
    y(i)=y(i-1)-0.2;
    A(i)=(b+z*y(i))*y(i);
    P(i)=b+2*y(i)*sqroot(1+z^2);
    E(i)=y(i)+0.02;
    Abar(i)=A(i-1)/2+A(i)/2;
    Pbar(i)=P(i-1)/2+P(i)/2;
    Rbar(i)=Abar(i)/Pbar(i);
    S(i)=(n*Q/Abar(i)/Rbar(i)^(2/3))^2;
    delx(i)=(E(i-1)-E(i))/(s-S(i));
    distance(i)=distance(i-1)+delx(i);

end
printf("y          A        P          E         Abar       Pbar          Rbar          S          delx          distace");
//printing the table
for i=1:6
    disp(i,"for row wise values of each parameter is for row=");
    printf("     %.2f",y(i));
    printf("     %.2f",A(i));
    printf("      %.2f",P(i));
    printf("     %.2f",E(i));
    printf("     %.2f",Abar(i));
```

```
    printf("    %.2f",Pbar(i));
    printf("    %.2f",Rbar(i));
    printf("    %.2e",S(i));
    printf("    %.2f",delx(i));
    printf("    %.2f",distance(i));

end
y5000=y(5)-(distance(5)-l)/(distance(5)-distance(6))
    *0.2;
disp("");
disp(y5000,"the depth of water at distance 5000m in
    (m):")
clear
```

Scilab code Exa 10.10 depth of water

```

//example 10.10
//page 395
clc; funcprot(0);
//initialisation of variable
//solving for y
z=2;//trapezoid ratio
n=0.012;//coeff
s=0.0002;//slope
Q=180;//discharge
Cm=1;//constant
l=5000;//distance
b=10;
g=9.81;
deff('y=f(x)','y=(10+2*x)/0.012*x*((10+2*x)*x
    /(10+4.472*x))^(2/3)*0.0002^0.5-180');
[x,v,info]=fsolve(1,f);
disp(x,"normal depth of water(ft)=");
y(1)=10;
```

```
A(1)=(b+z*y(1))*y(1);
P(1)=b+2*y(1)*sqroot(1+z^2);
R(1)=A(1)/P(1);
T(1)=50;
delx(1)=0;
x(1)=0;
Fy(1)=(1-Q^2*T(1)/g/A(1)^3)/(s-(n*Q/Cm/A(1)/R(1)^(2/3))^2);

//for the table
for i=2:6
    y(i)=y(i-1)-0.2;
    A(i)=(b+z*y(i))*y(i);
    P(i)=b+2*y(i)*sqroot(1+z^2);
    R(i)=A(i)/P(i);
    T(i)=T(1)-.8;
    Fy(i)=(1-Q^2*T(i)/g/A(i)^3)/(s-(n*Q/Cm/A(i)/R(i)^(2/3))^2);
    delx(i)=0.5*(Fy(i-1)+Fy(i))*0.2;
    x(i)=x(i-1)+delx(i);

end
printf("   y               A              P               R          T          F(y)        delx      x");
//printing the table
for i=1:6
    disp(i,"for row wise values of each parameter is for row=");
    printf("    %.2f",y(i));
    printf("    %.2f",A(i));
    printf("     %.2f",P(i));
    printf("    %.2f",R(i));
    printf("    %.2f",T(i));
    printf("    %.f",Fy(i));
    printf("    %.2f",delx(i));
    printf("    %.2f",x(i));

end
```

```
y5000=y(5)-(x(5)-1)/(x(5)-x(6))*0.2;
disp("");
disp(y5000,"the depth of water at distance 5000m in
    (m):")
clear
```

Scilab code Exa 10.11 force by water

```

//example 10.11
//page 395
clc; funcprot(0);
//initialisation of variable
yn=8.69;//depth
b=50;//width
Gamma=62.4;//unit weight
rho=1.94;//density
Q=4000;//flow rate
V=Q/b/yn;
Fs=0.5*Gamma*b*yn^2+rho*Q*V;
disp(Fs,"force by water(lbs)=");
clear
```

Scilab code Exa 10.12 flow rate

```

//example 10.12
//page 409
clc; funcprot(0);
//initialisation of variable
b=12;//width
y1=6;//depth
g=32.2;
```

```
delz=0.75//head loss
A=6*12;//area
y2=6-1-0.75;//depth
//using continuity
k=1.41;//V2/V1
//solving head loss
V1=((2*g*delz)/(k^2-1))^0.5;
Q=A*V1;
disp(Q,"flow rate(cfs)=");
clear
```

Chapter 11

Compressible Flow

Scilab code Exa 11.1 perfect gas

```
//example 11.1
//page 420
clc; funcprot(0);
//initialisation of variable
T1=15+273;//temperature
T2=90+273;//temperature
Cp=0.24;//heat constant
W=10;//weight
H=W*Cp*(T2-T1);
disp(H,"Change in Enthalpy(kcal)=");
clear
```

Scilab code Exa 11.2 energy equation

```
//example 11.2
//page 420
```

```
clc; funcprot(0);
//initialisation of variable
T1=15+273;//temperature
T2=90+273;//temperature
P1=40+101.3;//pressure
P2=360+101.3;//pressure
Cv=0.171;//heat constant
k=1.4;
W=10;
H=W*0.171*log((T2/T1)^1.4*(P2/P1)^-0.4);
disp(H,"Change in Enthalpy(kcal)=");
clear
```

Scilab code Exa 11.3 sound wave

```

//example 11.3
//page 422
clc; funcprot(0);
//initialisation of variable
P1=10;
P2=30;
T1=110+460;
k=1.4;//const
W=10;
Cv=0.157;//heat const
T2=T1*(P2/P1)^((k-1)/k);
H=W*Cv*(T2-T1);
disp(H,"Change in Enthalpy(Btu)=");
clear
```

Scilab code Exa 11.4 sound wave

```
//example 11.3
//page 426
clc; funcprot(0);
//initialisation of variable
//part1
S=1;
rho=S*1000;//density
Beta=2.2*10^9;//N/m^2
c=sqroot(Beta/rho);
disp(c,"speed of sound in water(m/s)=");
//part2
S=0.79;
rho=S*1000;//density
Beta=1.21*10^9;//N/m^2
c=sqroot(Beta/rho);
disp(c,"speed of sound in ethanol (m/s)=");
//part3
k=1.4;
R=287;
T=20+273;//temperature
c=sqroot(k*R*T);
disp(c,"speed of sound in air (m/s)=");
```

Scilab code Exa 11.5 downstream pressure

```
//example 11.5
//page 431
clc; funcprot(0);
//initialisation of variable
P1=1.5;//pressure
T1=500//40F=500R in temperature
V1=1500;
k=1.4;
```

```
R=1716;
c1=sqroot(k*R*T1);
M1=V1/c1;
M2=sqroot((2+(k-1)*M1^2)/(2*k*M1^2-k+1));
P2=P1*(1+k*M1^2)/(1+k*M2^2);
disp(P2,"pressure downstream (psia)");
T2=T1*(1+0.5*(k-1)*M1^2)/(1+0.5*(k-1)*M2^2);
T2=T2-460;
disp(T2,"temperature downstream (Farenheit)");
clear
```

Chapter 12

Turbomachines

Scilab code Exa 12.1 efficiency

```

//example 12.1
//page 443
clc; funcprot(0);
//initialisation of variable
Q=0.25;
Gamma=9810*0.8;
pi=3.14;
H=25;
T=350;//torque
N=1800;//rpm
omega=N/60*2*pi;
neta=Gamma*Q*H/T/omega;
disp(neta*100,"efficiency (%)");
clear
```

Scilab code Exa 12.2 power required

```
//example 12.2
//page 443
clc; funcprot(0);
//initialisation of variable
Q=0.4;
pi=3.14;
u2=31.4;//velocity
Gamma=9.81;//unit weight
g=9.81;
omega=2*pi*1500/60;//radial velocity
r2=0.2//m
b2=0.03//m
//part1
V2r=Q/2/pi/r2/b2;//radial velocity
V2t=u2-V2r*0.577;
v2=V2r/0.866;//speed
V2=sqroot(V2r^2+V2t^2);
disp(V2,"relative velocity (m/s):");
//part2
H=u2*V2t/g;
disp(H,"head of water (m)");
//part3
P=Gamma*Q*H;
disp(P,"power required(kW)");
clear
```

Scilab code Exa 12.3 rpm

```
//example 12.3
//page 450
clc; funcprot(0);
//initialisation of variable
Q1=82;//flow rate
```

```
Q2=100;//flow rate
H1=17.5;//head of water
H2=20;//head of water
d1=36;//diameter
N1=1500;//rpm
k1=Q2/Q1*N1*d1^3;//k1=N2*d2^3;
k2=H2/H1*N1^2*d1^2//k2=N2^2*d2^2;
d2=(k1^2/k2)^(1/4);
disp(d2,"diameter (cm)");
N2=k1/d1^3;
disp(N2,"rpm");
clear
```

Scilab code Exa 12.4 specific speed

```

//example 12.4
//page 454
clc; funcprot(0);
//initialisation of variable
Q=500/449;
D=8/12;
pi=3.14;
g=32.2;
N=1800;//rpm
A=pi*D^2/4;
V=Q/A;
f=0.022//from chart
HL=V^2/2/g*(12.1+224.9*f);
hs=HL+119.4;
Ns=N*sqroot(Q*449)/hs^0.75;
disp(Ns,"specific speed (rpm)");
clear
```

Scilab code Exa 12.5 maximum value of suction lift

```

//example 12.5
//page 457
clc; funcprot(0);
//initialisation of variable
H=60;
sigma_critical=0.08;
Pa=98000;//pressure
Pv=1707;//pressure of vapour
Gamma=9810;
HL=1;
NPSH_min=H*sigma_critical;
Hs_max=Pa/Gamma-Pv/Gamma-NPSH_min-HL;
disp(Hs_max,"maximum value of suction lift (m)");
clear
```