Scilab Textbook Companion for Fluid Mechanics and Hydraulic Machines by B. K. Sarkar[1]

Created by
Ankit Krishan Agrawal
B.Tech Chemical
Chemical Engineering
Visvesvaraya National Institute of Technology
College Teacher
Dr. R. P. Vijaykumar
Cross-Checked by
Chaitanya Potti

May 6, 2014

[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 and Hydraulic Machines

Author: B. K. Sarkar

Publisher: Allied Publishers Limited

Edition: 1

Year: 1999

ISBN: 81-7023-977-X

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 pressure and its measurement

Scilab code Exa 1.1 num

```
//problem 1.1
p=343350 //pressure at any point in pa
w=9810 //gravitational constant
h1=(p/w)
disp(h1 ,"pressure in term of height of water(m)")
s1=1
s2=13.6
h2=h1*s1/s2
disp(h2 ,"pressure in term of height of mercury(m)")
```

Scilab code Exa 1.2 num

```
//Problem 1.2
h1=0.75 //atm pressure in term of mercury
w=9810
w1=13.6*w //specific weight of mercury
```

```
Patm=w1*h1
w2=15000
h2=3 //
p=w2*h2 // gauge pressure
Pabs=Patm+p
disp(p,"gauge pressure(N/m2)")
disp(Pabs,"absolute pressure(N/m2)")
```

Scilab code Exa 1.3 num

```
//Problem 1.3
h1=2.5
h2=1.5
s1=1
s2=0.8
w=9810
p2=s2*w*h2 //Pressure intensity at interface
p1=s1*w*h1
p=p1+p2
disp(p2, "pressure intensity at interface(N/m2)")
disp(p, "pressure intensity at bottom(N/m2)")
```

Scilab code Exa 1.4 num

```
//problem 1.4
p=71613 //gauge pressure
w=9810
phead=p/w
patm=10.33
pabs=patm+phead
disp(pabs,"absolute pressure in term of water height
    in meters")
```

Scilab code Exa 1.5 num

```
//problem 1.5
h1=0.05
h2=0.1
s1=0.8
s2=13.6
w=9810
p=s2*h2*w //pressure at balance line
p1=s1*h1*w
pf=p-p1
disp(pf, "pressure in pipe(N/m2)")
```

Scilab code Exa 1.6 num

```
//problem 1.6
h1=0.2
h2=0.5
s1=0.9
s2=13.6
h=-(h1*s1+h2*s2)
w=9810
p=h*w
disp(p, "vacuum pressure (N/m2)")
```

Scilab code Exa 1.7 num

```
//problem 1.7
s1=0.8
```

```
s2=13.6
dh=0.4
h=dh*13.6-dh*0.8
w=9810
pd=w*h
disp(h, "pressure difference in height of water()")
disp(pd, "presuure difference in N/m2")
```

Scilab code Exa 1.8 num

```
//problem 1.8
s1=0.8
s2=0.7
h1=1.5
h2=0.3
h3=0.7
s3=13.6
hd=h2*s2+h3*s3-h1*s1
w=9810
pd=hd*w
disp(hd, "diffrence in pressure in term of height of
    water(m)")
disp(pd, "difference in pressure (N/m2)")
```

Scilab code Exa 1.9 num

```
//problem 1.9
s1=1.6
s2=0.8
s3=13.6
p1=98100
p2=176580
w=9810
```

```
h1=p1/w
h2=p2/w
h=(h2-h1+1.6*s2-4.1*s1)/(s3-s2)
disp(h.*100 ,"difference in mercury level(cm)")
```

Scilab code Exa 1.10 num

```
// problem 1.10
s1=1.2
s2=1
s3=0.7
h=(s1-s2)*0.3/(s2-s3)
disp(h*100,"difference in height(cm)")
```

Scilab code Exa 1.11 num

```
// problem 1.11
s1=0.8
s2=13.6
z=0.02
w=9810
h2=0.2
h1=0.1
h=h2*s2-h1*s1+(z*h2*(s2-s1))
p=h*w
disp(p,"pressure of the oil in N/m2")
```

Scilab code Exa 1.12 num

```
//problem 1.12
```

```
l=4
b=2
h=3
w=9810
s=0.8
p1=w*l*b*h*s
p2=w*s*l*h*1.5
p3=w*s*b*h*1.5
disp(p1,"total pressure on horizontal base")
disp(p2, "total pressure on larger vertical base")
disp(p3,"total pressure on smaller vertical walls")
```

Scilab code Exa 1.13 num

```
//problem 1.13
p=490500
w=9810
h=p/w
D=0.15
A=3.142*D*D*0.25
pt=w*A*h
h1=(D*D)/(16*h)
disp(pt,"total hydrostatic pressure in N")
disp(h1,"position of centre of pressure below the
    centre of pipe")
```

Scilab code Exa 1.14 num

```
//problem 1.14
w=9810
h=4
d=2
a=d*d*0.25*3.142
```

```
p=w*a*h
h1=d*d/64
T=p*(h1)
disp(T, "torque required to keep the disc in
    vertical position in N.m")
```

Scilab code Exa 1.15 num

```
//problem 1.15
w=9810
h=2
l=2
b=1
a=l*b
p=w*a*h
h1=h+(b*l*l*l/(12*b*l*l))
disp(p,"total pressure")
disp(h1,"location of its centre of pressure")
```

Scilab code Exa 1.16 num

```
//problem 1.16
h1=8
w=9810
wd=6
p1=0.5*w*h1*h1*wd
h2=4
p2=0.5*h2*w*h2*wd
h11=0.66666*h1
h22=0.6666*h2
p=p1-p2
hf=(p1*(h1-h11)-p2*(h2-h22))/p
disp(p,"resultant force")
```

```
disp(hf,"position of its line of action")
```

Scilab code Exa 1.17 num

```
//problem 1.17
z=9810
w=10
h=2
p=0.5*h*h*w*z
h1=h*0.6666
disp(p,"total hydrostatic thrust")
disp(h1,"its point of application")
```

Scilab code Exa 1.18 num

```
//problem 1.18
a1=1.4*2.2*1.4
x1=1.6+0.7
x11=(1.4*1.4/(12*2.3))+x1
x2=0.7
x22=(1.4*1.4/(12*0.7))+x2
z=9810
p1=z*a1*x1
p2=z*a1*x2/1.4
p=p1-p2
h=(p1*(3-x11)+p2*(1.4-x22))/p
f=(p1*(3-x11)-p2*(1.4-x22))/1.4
disp(p,"resultant force")
disp(f,"force acting horizontally on the top of the
    gate")
```

Scilab code Exa 1.19 num

```
//problem 1.19
s=1.5
s1=0.9
w=9810
h1=0.9
h2=0.6
p1=0.5*w*s*s1*h1*h1 //total pressure due to oil
p2=w*h1*h2*s*s1 // total pressure due to oil above
    water
p3=w*h2*h2*0.5*s //total pressure due to water
p=p1+p2+p3
h=((p1*0.6666*h1)+(p2*(h1+0.5*h2))+(p3*(0.6666*h2+h1
    )))/p
disp(p,"resultant pressure on the wall in N/m2")
disp(h,"position of centre of pressure from free
    surface")
```

Scilab code Exa 1.20 num

```
// problem 1.20
d=2.4
h=1.6
s=1.2
a=d*s
w=9810
p=w*a*h*s
h1=((2*s*s*s*d)/(12*a*h))+h
disp(p,"total pressure in N")
disp(h1,"its point of application")
```

Scilab code Exa 1.21 num

```
// problem 1.21
x=30
d=1.2
h=1.5
w=9810
z=sin(x*3.142/180)
h1=(z*d*0.5)+h
a=0.25*3.142*d*d
p=a*w*h1
h11=(d*d*z*z)/(16*h1)+h1
disp(p,"total pressure")
disp(h11,"position of centre of pressure")
```

Scilab code Exa 1.22 num

```
// problem 1.22
d=2
z=0.5
h=z+0.5*d
w=9810
a=3.142*d*d*0.25
p=a*w*h
h11=(1/(16*1.5))+1.5
disp(p,"total pressure on the plate")
disp(h11,"position of centre of pressure")
```

Scilab code Exa 1.23 num

```
// problem 1.23
x=30
z=sin(x*3.142/180)
h=6-(z*0.5)
l=1
```

```
b=4
a=l*b
w=9810
p=w*a*h
h11=(z*z)/(12*h)+h
f=p*0.5072
disp(f,"force normal to the gate at point B")
```

Scilab code Exa 1.24 num

```
// problem 1.24
x=30
z=sin(3.142*x/180)
d=1.4
h=3
b=1.5
h1=z+d
a=0.5*h*b
w=9810
p=w*a*h1
h11=((z*z*h*h*h*b)/(36*a*h1))+h1
disp(p,"total pressure on the plate")
disp(h11,"position of centre of pressure")
```

Scilab code Exa 1.25 num

```
// problem 1.25
d=1.8
h=2.4
w=9810
s=0.8
p1=w*d*d*h*0.25*3.142
h1=((d*d)/(16*h))+h
```

```
p=w*(s*1.5+2.4)
p2=p*3.142*d*d*0.25
p=p2-p1
ab=w*(s*1.5+1.5)
de=w*(s*1.5+3.3)
ce=de-ab
x=((0.5*ce*d*0.3)/(0.5*(ab+de)*d))
h2=x+h
h12=h1-h2
disp(p, "change in total pressure")
disp(h2,"position of centre of pressure")
disp(h12,"change in position of centre of pressure")
```

Scilab code Exa 1.26 num

```
// problem 1.26
l=5
r=3
a=l*r
h=r*0.5
w=9810
ph=w*a*h
pv=w*0.25*3.142*r*r*l
p=sqrt((ph*ph)+(pv*pv))
z=ph/pv
theta=atand(z)
disp(p,"resultant pressure on the gate")
disp(theta,"angle of resultant force with vertical")
```

Scilab code Exa 1.27 num

```
// problem 1.27
s=5
```

```
z=sind(45)
a=2*s*z
h=s*z
w=9810
ph=w*a*h
pv=w*((0.25*s*s*3.142)-(0.5*a*h))
disp(ph,"horizontal pressure")
disp(pv,"vertical pressure")
```

Chapter 2

equillibrium of floating bodies

Scilab code Exa 2.1 num

```
//problem 2.1
l=4
w=2
sg=0.75
z=9810
d=0.5
v=l*w*d
wg=v*z*sg
s=24000
V=((z*v)-wg)/s
V1=(v*z-wg)/(s-z)
disp(V,"volume in m3 when block is completely in
    water")
disp(V1,"volume in m3 when block and concrete
    completely under water")
```

Scilab code Exa 2.2 num

```
//problem 2.2
d=1
s=0.75
w=9810
a=3.142*d*d/4
h=d*0.5
p=w*h*s // intensity of pressure on at horizontal
    interface
v=p*a  //vertical upward force
w1=w*s*a*d/3 // weight of oil in upper hemisphere
vf=v-w1  // net vertical upward force
disp(vf,"minimum weight of upper hemisphere in N")
```

Scilab code Exa 2.3 num

```
// problem 2.3
w=90
// By archemde's principle
// weight of water dispalced = weight of sphere
z=9810
v=w/z
d=(v*12/3.142)^0.33333
disp(d,"external diameter of hollow of sphere in m")
```

Scilab code Exa 2.4 num

```
// problem 2.4
s1=13.6
s2=7.8
s3=1
// by archimede principle
// weight of body = weight of liquid displaced
// s2=s1*x+s3*(1-x)
```

```
x=(s2-s3)/(s1-s3)
disp(x,"fraction of steel below surface of mercury")
```

Scilab code Exa 2.5 num

```
// problem 2.5
w=9810
do=1.25
a=3.142*do*do*0.25
f1=w*a*1
f2=w*a*3 // buoyancy force of 3m lenght of pipe
di=1.2
s=9.8
wg=w*s*3*((1.25^2)-(1.2^2))*0.25*3.142
fa=f2-wg
disp(f1,"buoyancy force in N/m")
disp(fa,"upward force on anchor")
```

Scilab code Exa 2.6 num

```
// problem 2.6
a=0.25
s1=11.5
s2=1
z=9810
v1=a*a*a*0.5
wc=v1*z
h=0.016
// by archimede's principle
v2=(a*0.5+h)*a*a // volume of cube submergerd
v=(v2-v1)/(s1-s2)
wl=v*s1*z
disp(wl,"weight of lead attached")
```

Scilab code Exa 2.7 num

```
// problem 2.7
s1=19.3
s2=9
x=14/24
wg=x*10
wc=(1-x)*10
vg=wg/s1
vc=wc/s2
vt=vg+vc
disp(vt,"volume of 10gm,14 carat gold in cm3")
```

Scilab code Exa 2.8 num

```
// problem 2.8
h1=0.05
h2=0.015
s=41/40
l=h1/(s-1)
w1=25
// applying bakance in vertical direction
w=w1*(l+h1)/(h2)
disp(w,"weight of ship in in N")
```

Scilab code Exa 2.9 num

```
// problem 2.9
w=700
```

```
w1=20000
d=0.5
h=1
wd=250
z=9810
f=z*3.142*d*d*2*0.25/3
n=(w*4+w1)/(f-250)
n1=round(n)
disp(n1,"number of drums")
```

Scilab code Exa 2.10 num

```
// problem 2.10
a=0.12
l=1.8
s=0.7
z=9810
wp=s*a*a*l*z
v=a*a*(l-0.2)
w=v*z
t=w-wp
s.p=110000
// applying equilibrium balance
w=t/(1-(9810/s.p))
disp(w,"weight of lead in N")
```

Scilab code Exa 2.11 num

```
// problem 2.11
d=4
h=4
s=0.6
s1=1
```

```
h1=s*h/s1
v=3.142*d*d*0.25*h1
x=h1/2
cog=h/2
h2=cog-x
a=3.142*d*d*d*d/64
bm=a/v
mh=bm-h2
disp(mh,"metacentric height in m,negative sign
   indicte that cylinder is in unstable equilibrium"
   )
```

Scilab code Exa 2.12 num

```
// problem 2.12
d=4
s1=0.6
s2=0.9
l=1
h=s1*l/s2
cob=h/2
cog=l/2
dcog=cog-cob
i=3.142*d*d*d*d/64
v=3.142*0.25*d*d*h
bm=i/v
bm=dcog
l=(6*1.5)^0.5
disp(l,"maximium lenght of cylinder in m")
```

Scilab code Exa 2.13 num

```
// problem 2.13
```

```
s=2
w=340
v=0.5*s*s*s
z=9810
w1=z*4
gb=s/4-s/8
i=s*s*s*s/(12)
v=4
bm=i/v
gm=bm+gb
p=w/(w1*gm)
theta=atand(p)
disp(theta*60,"angle through which cube will tilt in
    minutes")
```

Scilab code Exa 2.14 num

```
// problem 2.14
l=60
b=9
w=16*1000000
w1=160*1000
y=6
q=3
s.p=10104
i=0.75*l*b*b/12
v=w/s.p
bm=i/v
gm=(w1*y)/(w*tand(q))
mcd=2-bm
cogd=gm+mcd
disp(gm,"metacentric height")
disp(cogd,"position of centre of gravity below the
   water line")
```

Scilab code Exa 2.15 num

```
// problem 2.15
w=450000
y=5.5
w1=80*1000000
q=3
gm=(w*y)/(w1*tand(q))
p=12.5*1000
n=120
T=(p*60000)/(2*3.142*n)
z=T/(w1*gm)
theta=atand(z)
disp(theta,"angle of heel in degree")
```

Chapter 3

Flow of fluids

Scilab code Exa 3.1 num

```
// problem 3.1
d1=0.3
d2=0.1
z1=6
z2=3
p1=200*1000
q1=0.07
a1=3.142*d1*d1/4
a2=3.142*d2*d2/4
v1=q1/a1
v2=q1/a2
w=9810
g=9.81
//applying bernoulli equation
p2=((z1-z2)+(((v1^2)-(v2^2))/(2*g))+(p1/w))*w
disp(p2,"pressure at point B in N/m2")
```

Scilab code Exa 3.2 num

```
// problem 3.2
d1=1
d2=0.5
q=0.1
p1=70*1000
l=60
z2=0
z1=l/20
a1=3.142*d1*d1/4
a2=3.142*d2*d2/4
v1=q/a1
v2=q/a2
w=9810
g=9.91
// applying bernoulli equation
p2=((z1-z2)+(((v1^2)-(v2^2))/(2*g))+(p1/w))*w
disp(p2,"presssure at lower end in N/m2")
```

Scilab code Exa 3.3 num

```
// problem 3.3
d1=0.2
d2=0.1
l=4
x=30
p1=392.4*1000
q=0.035
z1=0
z2=l*sind(x)
a1=3.142*d1*d1/4
a2=3.142*d2*d2/4
v1=q/a1
v2=q/a2
w=9810
g=9.81
```

```
p2=((z1-z2)+(((v1^2)-(v2^2))/(2*g))+(p1/w))*w
disp(p2,"pressure intensity at outlet in N/m2")
```

Scilab code Exa 3.4 num

```
// problem 3.4
d1=0.2
d2=0.1
d3=0.15
v1=4
g=9.81
vh1=(v1^2)/(2*g)
a1=3.142*d1*d1/4
a2=3.142*d2*d2/4
a3=3.142*d3*d3/4
v2=(a1*v1)/a2
vh2=(v2^2)/(2*g)
v3=(a1*v1)/a3
vh3=(v3^2)/(2*g)
q=a1*v1
mf=q*1000
disp(vh1,"velocity head at point 1")
disp(vh2,"velocity head at point 2")
disp(vh3,"velocity head at point 3")
disp(mf,"mass flow rate in kg/sec")
```

Scilab code Exa 3.5 num

```
// problem 3.5
d1=0.2
d2=0.5
p1=98.1*1000
p2=58.86*1000
```

```
q=0.2
z1=0
z2=4
g=9.81
s=0.87
a1=3.142*d1*d1/4
a2=3.142*d2*d2/4
v1=q/a1
v2=q/a2
w=9810
ph1=p1/(w*s)
ph2=p2/(w*s)
vh1=(v1^2)/(2*g)
vh2=(v2^2)/(2*g)
th1=vh1+ph1+z1
th2=vh2+ph2+z2
tl=th1-th2
disp(tl,"loss of head in m,flow from 1 to 2")
```

Scilab code Exa 3.6 num

```
// problem 3.6
d1=0.3
d2=0.15
a1=3.142*d1*d1/4
a2=3.142*d2*d2/4
H=0.18
Cd=0.85
s2=13.6
s1=1
w=9810
h=H*((s2/s1)-1)
g=9.81
q=(Cd*a1*a2*((2*g*h)^0.5))/(((a1^2)-(a2^2))^0.5)
q1=q*1000
```

```
disp(q1,"rate of flow in litres/sec")
```

Scilab code Exa 3.7 num

```
// problem 3.7
q=0.1
d1=0.2
Cd=0.9
H=0.4
s1=1
s2=13.6
g=9.8
h=H*((s2/s1)-1)
a1=3.142*d1*d1/4
z=1+(((Cd*a1*((2*g*h)^0.5))/q)^2)
a2=((a1^2)/z)^0.5
d2=(4*a2/3.1)^0.5
disp(d2,"diameter of throat in m")
```

Scilab code Exa 3.8 num

```
// problem 3.8
q=0.08
d1=0.3
d2=0.15
a1=3.142*d1*d1/4
a2=3.142*d2*d2/4
h=1.5
g=9.81
z=(a1*a2*((2*g*h)^0.5))/(((a1^2)-(a2^2))^0.5)
Cd=q/z
disp(Cd,"co-efficient of meter")
```

Scilab code Exa 3.9 num

```
// problem 3.9
s2=13.6
s1=0.9
H=0.25
h=H*((s2/s1)-1)
Cd=0.98
w=9810*s1
d1=0.3
d2=0.15
a1=3.142*d1*d1/4
a2=3.142*d2*d2/4
dz=0.3
g=9.81
q=(Cd*a1*a2*((2*g*h)^0.5))/(((a1^2)-(a2^2))^0.5)
dp=(h+dz)*w
disp(q,"discharge of the oil in m3/sec")
disp(dp,"pressure diffrence in entrance and throat
    section ")
```

Scilab code Exa 3.10 num

```
// problem 3.10
H=0.1
w=9810
sw=12
h=H*(w/sw)
Cv=0.96
g=9.81
v=Cv*((2*g*h)^0.5)
v1=v*18/5
```

```
disp(v1,"speed of the plane")
```

Scilab code Exa 3.11 num

```
// problem 3.11
d1=0.05
d2=0.025
a1=3.142*d1*d1/4
a2=3.142*d2*d2/4
Cd=0.94
g=9.81
k=((((a1^2)/(a2^2))-1)*(1-(Cd^2)))/(2*g*(a1^2)*(Cd
   ^2))
disp(k,"venturimeter constant m-5/s2")
```

Scilab code Exa 3.12 num

```
// problem 3.12
d0=0.05
d1=0.1
H=0.09
s2=13.6
s1=1
g=9.81
h=H*((s2/s1)-1)
Cd=0.65
a1=3.142*d1*d1/4
a0=3.142*d0*d0/4
q=(Cd*a1*a0*((2*g*h)^0.5))/(((a1^2)-(a0^2))^0.5)
q1=q*(10^6)
disp(q1,"actual flow rate in cm3/sec")
```

Chapter 4

flow through orifices

Scilab code Exa 4.2 num

```
// problem 4.2
q=0.0982
d=0.12
H=10
x=4.5
y=0.54
g=9.81
Vth=(2*g*H)^0.5
a=3.142*d*d/4
Qth=Vth*a
Cd=q/Qth
Cv=((x*x)/(4*y*H))^0.5
Cc=Cd/Cv
disp(Cc,Cv,Cd,"Cd ,Cv, Cc  of the orifice")
```

Scilab code Exa 4.3 num

```
// problem 4.3
```

```
D=0.1
d=0.05
q=0.02
A=3.142*D*D/4
g=9.81
w=9810
p=58.86*1000
v=q/A
Vh=(v*v)/(2*g)
Ph=p/w
Th=Ph+Vh
a=3.142*d*d/4
Cd=q/(a*((2*g*Th)^0.5))
disp(Cd,"co-efficient of discharge")
```

Scilab code Exa 4.4 num

```
// problem 4.4
Cd=0.6
H1=3
H2=4
b=2
g=9.81
Q=(2*Cd*b*((2*g)^0.5)*((H2*H2*H2)^0.5-(H1*H1*H1)
    ^0.5))/3
q1=Q*1000
disp(q1,"dischsrge flow rate in litres/sec")
```

Scilab code Exa 4.5 num

```
//problem 4.5
b=0.75
H1=2.25
```

```
H2=2.5
H=0.5
g=9.81
Cd=0.62
Q=Cd*b*(H2-H1)*((2*g*H)^0.5)
Q1=Q*1000
disp(Q1,"discherge through the orifice in litres/sec
   ")
```

Scilab code Exa 4.6 num

```
// problem 4.6
b=2
d=3
H1=4
H2=7
H=0.8+H1
Cd=0.62
g=9.81
Q1=(2*Cd*b*((2*g)^0.5)*((H*H*H)^0.5-(H1*H1*H1)^0.5))
   /3
Q2=Cd*b*(H2-H)*((2*g*H)^0.5)
Q=Q1+Q2
q=Q*1000
disp(q,"Discharge in litres/sec")
```

Scilab code Exa 4.7 num

```
// problem 4.7
l=20
b=10
a=l*b
H1=1.5
```

```
Cd=0.62
H2=0
T=5*60
n=4
g=9.81
a1=(2*a*((H1^0.5)-(H2^0.5)))/(Cd*T*((2*g)^0.5))
d=((4*a1)/(3.142*n))^0.5
d1=d*100
disp(d1,"diameter of the orifice in cm")
```

Scilab code Exa 4.8 num

```
// problem 4.8
l1=10
b1=5
l2=5
b2=2.5
a1=l1*b1
a2=l2*b2
d=0.2
a=3.142*d*d/4
H1=4
g=9.81
q=25
Cd=0.62
h1=q/a1
h2=q/a2
H2=H1-h1-h2
T=(2*a1*a2*((H1)^0.5-(H2)^0.5))/(a*Cd*(a1+a2)*((2*g)
    ^0.5))
disp(T,"time taken to flow 25 m3 in sec")
```

Scilab code Exa 4.9 num

```
// problem 4.9
Cd=0.8
D=2
r=1
H1=2
d=0.1
a=3.142*d*d/4
l=8
g=9.81
T=(4*l*((2*r)^1.5-(2*r-H1)^1.5))/(3*Cd*a*((2*g)^0.5)
    )
disp(T/60,"time taken for emptying the boiler in min
    ")
```

Scilab code Exa 4.10 num

```
// problem 4.10
r=5
h1=5
d=0.08
a=0.005
h2=h1-2
Cd=0.6
g=9.81
z=((2*r*((h1^1.5)-(h2^1.5)))/3)-((((h1^2.5)-(h2^2.5)
    ))/5)
T=(z*2*3.142)/(Cd*a*((2*g)^0.5))
disp(T,"time in seconds to lower the level by 2m")
```

Chapter 5

Notches and weirs

Scilab code Exa 5.1 num

```
// problem 5.1
q=0.2
Cd=0.62
g=9.81
// using the relation
z=(3*q*(2^1.5))/(2*Cd*((2*g)^0.5))
b=z^0.4
disp(b*100,"the lenght of the notch in cm ")
```

Scilab code Exa 5.2 num

```
// problem 4.2
b=1
H=0.15
Cd1=0.62
x=90
g=9.81
Cd2=0.58
```

```
Q1=2*Cd1*b*((2*g*H*H*H)^0.5)/3
z=(15*Q1)/(8*Cd2*((2*g)^0.5)*tand(x/2))
H1=z^0.4
disp(H1*100,"the depth over the traingular veir in
    cm")
```

Scilab code Exa 5.3 num

```
// problem 5.3
x=90
Cd=0.62
H=0.36
g=9.81
Q=(8*Cd*tand(x/2)*((2*g)^0.5)*(H^2.5))/15
q=Q*1000
disp(q,"the actual discharge in litres/sec")
```

Scilab code Exa 5.4 num

```
// problem 5.4
x=90
H=0.2
b=0.3
Cd=0.62
g=9.81
q1=(8*Cd*tand(x/2)*((2*g)^0.5)*(H^2.5))/15
q2=2*Cd*b*((2*g*H*H*H)^0.5)/3
q=q1+q2
disp(q,"discharge over the trapezoidal notch in m3/
    sec")
```

Scilab code Exa 5.5 num

```
// problem 5.5
a=20*(10^6)
x=0.03
q=a*x
qf=q*0.4/3600
n=2
H=0.6
// Using Francis formula
L=(qf/(1.84*(H^1.5)))+(0.1*n*H)
disp(L,"the lenght of the weir in m")
```

Scilab code Exa 5.6 num

```
// problem 5.6
L=36
v1=2
g=9.81
H=1.2
H1=(v1*v1)/(2*g)
n=2*12
w=0.6
Nv=11
Lf=L-(Nv*w)
Q=1.84*(Lf-(0.1*n*(H+H1)))*((H+H1)^1.5-(H1^1.5))
disp(Q,"dischsrge over the weir in m3/sec")
```

Scilab code Exa 5.7 num

```
// problem 5.7
l=0.77
H=0.39
```

```
H1=0.6
Dp=H+H1
Cd=0.623
g=9.81
Q=(2*Cd*l*((2*g*H*H*H)^0.5))/3
v=Q/(l*Dp)
Ha=(v*v)/(2*g)
q=(2*Cd*l*((2*g)^0.5)*(((H+Ha)^1.5)-(Ha^1.5)))/3
disp(q,"discharge in m3/sec")
```

Scilab code Exa 5.8 num

```
// problem 5.8
Q1=0.005
Cd=0.62
g=9.81
Q2=0.75
h=0.07
z=(Q1*15)/(8*Cd*((2*g)^0.5)*(h^2.5))
H=h*((Q2/Q1)^0.4)
W=2*H*z
disp(W,"width of the water surface in m")
```

Scilab code Exa 5.9 num

```
// problem 5.9
b=4
H=0.2
Cd=0.62
g=9.81
Q1=2*Cd*b*((2*g*H*H*H)^0.5)/3
Q2=(2*Cd*((2*g)^0.5)*(H^1.5)*(b-(0.2*H)))/3
m=0.405+(0.003/H)
```

```
Q3=m*b*((2*g)^0.5)*(H^1.5)
disp(Q1,"discharge when end contraction are
   supressed in m3/sec")
disp(Q2,"discharge when end contraction are taken
   into account by francis formula in m3/sec")
disp(Q3,"discharge when end contraction are taken
   into account by bazin formula in m3/sec")
```

Scilab code Exa 5.10 num

```
// problem 5.10
Cd=0.6
x=45
H=0.5
g=9.81
q1=(8*Cd*tand(x/2)*((2*g)^0.5)*(H^2.5))/15
disp(q1,"rate of flow over the rectangular notch in
   m3/sec")
dq1=0.025
dh=dq1*H/2.5
h1=H+dh
h2=H-dh
disp(h1*100,h2*100,"limiting values of head in
   centimeters")
```

Scilab code Exa 5.11 num

```
// problem 5.11
Cd=0.6
x=90
q=0.05
g=9.81
dh=0.00025
```

```
z=(15*q)/(8*Cd*((2*g)^0.5)*(tand(x/2)))
H=z^0.4
error=2.5*(dh/H)
disp(error*100,"the percentage error in the
   discharge")
```

Chapter 6

Flow through pipes

Scilab code Exa 6.1 num

```
// problem 6.1
Rn=1700
v=0.744*(10^-4)
d=0.05
V=(Rn*v)/d
Vmax=2*V
x=0.00625
r=(d/2)-x
V1=Vmax*(1-(2*r/d)^2)
disp(V1,"velocity at the point 6.25 mm from the wall
    in m/sec")
```

Scilab code Exa 6.2 num

```
// problem 6.2
d=0.3
p=787
v=1.6*(10^-6)
```

```
Rn=2000
V=Rn*v/d
a=3.142*d*d/4
Q=a*V
disp(Q,"maximum flow rate for which the flow is
    maximium")
```

Scilab code Exa 6.3 num

```
// problem 6.3
vd=8*(10^-3)*0.1
p=996
vk=vd/p
disp(vk,"kinematic viscosity in m2/sec")
```

Scilab code Exa 6.4 num

```
// problem 6.4
u=1.5/98.1
s=0.81
d=0.14
Q=0.03
g=9.81
p=s*1000/g
a=3.142*d*d/4
V=Q/a
Rn=V*p*d/u
disp(Rn,"Rn less than 2000, flow is laminar")
```

Scilab code Exa 6.5 num

```
// problem 6.5
d=0.2
Q=0.088
l=5
vd=0.01
p=1000
v=vd/(p*10)
a=3.142*d*d/4
g=9.81
V=Q/a
Re=V*d/v
f=0.0018+(0.092/(3*(Re^0.5)))
Hf=(4*f*l*V*V)/(d*2*g)
disp(Hf,"head lost due to friction in m")
```

Scilab code Exa 6.6 num

```
// problem 6.6
s=0.75
d=0.2
l=1000
Q=3/60
f=0.01
a=3.142*d*d/4
V=Q/a
g=9.81
Hf=(4*f*l*V*V)/(d*2*g)
w=g*s*1000
dp=w*Hf
disp(dp,"pressure drop along its entire lenght in N/
    m2")
```

Scilab code Exa 6.7 num

```
// problem 6.7
d=0.3
g=9.81
l=400
Q=0.3
f=0.032
a=3.142*d*d/4
V=Q/a
Lentrance=(0.5*V*V)/(2*g)
Hf=(4*f*l*V*V)/(d*2*g)
Lexit=(V*V)/(2*g)
Totalloss=Lentrance+Hf+Lexit
disp(Totalloss,"diffrenc in elevation in m")
```

Scilab code Exa 6.8 num

```
// problem 6.8
l=40
l1=20
l2=20
d1=0.15
d2=0.3
H=8
f=0.01
h1=(2*d2*d2)/(d1*d1)
h2=4*f*l1*16/d1
h3=9
h4=4*f*l2/d2
g=9.81
ht=h1+h2+h3+h4+1
V2=(H*2*g/ht)^0.5
a2=3.142*d2*d2/4
Q=V2*a2
disp(Q*1000,"rate of low in litres/sec")
```

Scilab code Exa 6.9 num

```
// problem 6.9
l=2000
d=0.2
V=0.8
f=0.01
g=9.81
hf=(4*f*l*V*V)/(d*2*g)
disp(hf,"Head loss due to friction in pipeline")
```

Scilab code Exa 6.10 num

```
// problem 6.10
d1=0.15
d2=0.1
Q=0.03
a1=3.142*d1*d1/4
a2=3.142*d2*d2/4
V1=Q/a1
V2=Q/a2
c=0.6
g=9.81
dz=(V2*V2/(2*g))-(V1*V1/(2*g))+(V2*V2/(2*g))*((1/c
   -1)^2)
w=9810
dp=dz*w
disp(dp,"pressure loss across the contraction in N/
   m2")
```

Scilab code Exa 6.11 num

```
// problem 6.11
d1=0.5
d2=0.25
p1=103005
p2=67689
p3=p2
w=9810
g=9.81
c=0.65
z=1-(1/16)+((1/c-1)^2)
dp=p1-p2
v2=((dp*2*g)/(w*z))^0.5
a2=3.142*d2*d2/4
Q=v2*a2
disp(Q*1000,"rate of flow in m3/sec")
v3=v2
v1=v3/4
v4=v1
he=(v3-v4)^2/(2*g)
p4=w*((p3/w)+((v3*v3-v4*v4)/(2*g))-he)
disp(p4,"pressure at the 50 cm enlarge section in N/
    m2")
```

Scilab code Exa 6.12 num

```
// problem 6.12
d=0.04
v=2
dp=20000
l=8
w=9810
u=(dp*d*d)/(32*l*v)
disp(u,"viscosity of the flowing oil")
```

Scilab code Exa 6.13 num

```
// problem 6.13
d=0.25
l=12*1000
w=9320
i=1/300
v=20*(10^-4)
a=3.142*d*d/4
q=0.015
V=q/a
g=9.81
Rn=V*d/v
f=16/Rn
hf=(4*f*l*V*V)/(2*d*g)
H=hf+(i*l)
p=(w*q*H)/1000
disp(p,"power required to pump the oil")
```

Scilab code Exa 6.14 num

```
// problem 6.14
l=600
H=160
p=1200*1000
n=0.85
f=0.005
hf=H/3
w=9810
H1=H-hf
q=p/(w*H1*n)
```

```
d=((f*l*q*q)/(3*hf))^0.2
disp(d*100,"minimium diameter of the pipe in cm")
```

Scilab code Exa 6.15 num

```
// problem 6.15
d=0.25
l=500
a=3.142*d*d/4
f=0.006
q=0.04
g=9.81
p2=250*1000
V=q/a
hf=(4*f*l*V*V)/(d*2*g)
z1=0
z2=25
w=9810
p1=((p2/w)+z2+hf)*w
disp(p1,"pressure at point A is N/m2")
```

Scilab code Exa 6.16 num

```
// problem 6.16
q=0.15/(2.5*60)
d=0.03
p1=9810
p2=6867
l=2
w=9810
hf=(p1-p2)/w
a=3.142*d*d/4
V=q/a
```

```
g=9.81
f=(hf*2*g*d)/(4*l*V*V)
C=V*((4*l)/(d*hf))^0.5
disp(f,"darcy co−efficient")
disp(C,"Chezy formula")
```

Scilab code Exa 6.17 num

```
// problem 6.17
a=90
H1=10
d=0.15
l=400
H2=7
g=9.81
f=0.008
z=3.142*d*d*((2*g)^0.5)
z1=(1.5+(4*f*l/d))^0.5
T=(8*a*z1*(H1^0.5-H2^0.5))/z
disp(T/3600,"time to lower the level from 10m to 7m
    in hr")
```

Scilab code Exa 6.18 num

```
// problem 6.18
q=0.08
d1=0.25
d2=1
l1=1500
l2=1500
a1=3.142*d1*d1/4
a2=3.142*d2*d2/4
v2=q*4/(3.142*((1/32)+1))
```

```
v1=v2*0.5
q1=v1*a1
q2=v2*a2
disp(q1*1000,q2*1000,"disharge through  pipe in m3/
    sec")
```

Chapter 7

Flow through open channels

Scilab code Exa 7.1 num

```
// problem 7.1
b=6
i=1/1000
d=2
C=50
A=b*d
m=A/(b+2*d)
Q=A*C*((i*m)^0.5)
disp(Q,"flow rate assuming chezys constant eqaul to
   50 in m3/sec")
```

Scilab code Exa 7.2 num

```
// problem 7.2
b=5
d=3
i=1/1000
C=55
```

```
A=b*d
m=A/(b+2*d)
Q=A*C*((i*m)^0.5)
v=Q/A
disp(Q,v,"flow rate assuming chezys constant eqaul
    to 55 in m3/sec & velocity of flow in m/sec")
```

Scilab code Exa 7.3 num

```
// problem 7.3
b=2.5
d=2.5
C=56
A=b*(7.5+d)*0.5
P=2.5+((b*b+d*d)^0.5)*2
m=A/P
i=1/1200
Q=A*C*((m*i)^0.5)
disp(Q*1000,"the diacharge through the channel in
    litres/sec")
```

Scilab code Exa 7.4 num

```
// problem 7.4
b=3.5
i=1/1000
d=1.5
C=60
y=60
x=1.5/tand(y)
w=b+x*2
A=(w+b)*0.5*d
P=b+2*((x*x+d*d)^0.5)
```

```
m=A/P
Q=A*C*((m*i)^0.5)
disp(Q*1000,"discharge carried by the canal in
   litres/sec")
```

Scilab code Exa 7.5 num

```
// problem 7.5
b=9
i=1/3000
d=1.2
w=b+d
A=(w+b)*0.5*d
P=b+2*((d*d+d*d*0.25)^0.5)
m=A/P
C=50
V=C*((m*i)^0.5)
Q=V*A
disp(Q*1000,V,"average velocity of flow, rate of
   flow")
```

Scilab code Exa 7.6 num

```
// problem 7.6
Q=0.1
b=0.6
C=56
d=0.3
a=b*d
v=Q/a
p=b+2*d
m=a/p
i=(v*v)/(C*C*m)
```

```
k=a*C*(m^0.5)
disp(k,i,"bottom slope neccessary for uniform flow,
    conveyance of the channel section")
```

Scilab code Exa 7.7 num

```
// problem 7.7
i=1/1000
d=1.5
Cd=0.55
a=d*d
C=40
g=9.81
m=d
Q=a*C*((d*i)^0.5)
H=(3*Q/(Cd*2*((2*g)^0.5)))^0.4
height=d+3-H
disp(height,"height of the dam in m")
```

Scilab code Exa 7.8 num

```
// problem 7.8
b=1.4
d=1.4
n=1/4
i=1/700
N=0.025
a=d*(b+(n*d))
p=b+(2*d*((n*n+1)^0.5))
m=a/p
q=(a*(m^0.6666)*(i^0.5))/N
disp(q*1000,"discharge from the trapezoidal channel
    in litres/sec")
```

Scilab code Exa 7.9 num

```
// problem 7,9
Q=0.3
D=1.5
N=0.02
A=3.142*D*D/(4*2)
p=3.142*D/2
m=A/p
i=((Q*N)/(A*(m^0.6666)))^2
disp(i,"the slope of the sewer")
```

Scilab code Exa 7.10 num

```
// problem 7.10
D=2.4
d=1.5
i=1/1500
N=0.02
a=(d-(D/2))/(D/2)
z=acos(a)
z1=3.142-z
P=D*z1
A=D*D*0.25*(z1-(sin(2*z1)/2))
m=A/P
Q=(A*(m^0.6666)*(i^0.5))/N
disp(Q*1000,"the discharge through the sewer in
    litres/sec")
```

Scilab code Exa 7.11 num

```
// problem 7.11
b=1.5
d=0.8
Q=0.75
i=1/2500
A=b*d
P=b+(2*d)
m=A/P
C=Q/(((m*i)^0.5)*A)
z=(157.6/C)-1.81
K=z*(m^0.5)
disp(K,C,"Chezys constant and coefficient of
    roughness")
```

Scilab code Exa 7.12 num

```
// problem 7.12
b=10
d=4
i=1/1000
N=0.03
A=b*d
P=b+(2*d)
m=A/P
z1=23+(0.00155/i)+(1/N)
z2=1+((23+(0.00155/i))*(N/(m^0.5)))
C=z1/z2
Q=A*C*((m*i)^0.5)
disp(Q*1000,"discharge through the rectangular
    channel in litres/sec")
```

Scilab code Exa 7.13 num

```
// problem 7.13
b=4
d=1.5
i=1/1000
C=55
A=b*d
P=b+(2*d)
m=A/P
Q=A*C*((m*i)^0.5)
d1=(A/2)^0.5
b1=d1*2
disp(d1,b1,"the new dimension of the channel")
P1=b1+(2*d1)
m1=A/P1
Q1=A*C*((m1*i)^0.5)
Qf=Q1-Q
disp(Qf,"increase in discharge in m3/sec")
```

Scilab code Exa 7.14 num

```
// problem 7.14
i=1/2500
N=0.02
Q=14
n=1/(tand(60))
a=(3^0.5)
d=((Q*N*(2^0.6666))/((i^0.5)*a))^(3/8)
b=d*2/(3^0.5)
disp(d,b,"dimension of the channel")
```

Scilab code Exa 7.15 num

```
// problem 7.15
Q=20.2
i=1/2500
C=60
n=1/(tand(60))
a=(3^0.5)
d=((Q*(2^0.5))/(C*a*(i^0.5)))^0.4
b=2*d/(a)
disp(d,b,"dimension of the cross section in m")
```

Scilab code Exa 7.16 num

```
// problem 7.16
Q=10
V=2
A=Q/V
n=1
d=(A/1.828)^0.5
b=0.828*d
A1=(b+(2*d*((n*n+1)^0.5)))
disp(A1,"area in m2 of lining required for 1m canal
    lenght")
```

Scilab code Exa 7.17 num

```
// problem 7.17
n=1
Q=14
i=1/1000
C=44
a=1.828
d=((Q*(2^0.5))/(C*a*(i^0.5)))^0.4
b=d*0.828
```

```
cost=(b+n*d)*4
A=1.828*d*d
C1=70
d1=((Q*(2^0.5))/(C1*a*(i^0.5)))^0.4
b1=0.828*d1
cost1=(b1+n*d1)*4
costl=(b1+(2*d1*((n*n+1)^0.5)))
totalcost= cost1+costl
disp(d1,b1,"lined channel is cheaper ,dimension in m
  ")
```

Scilab code Exa 7.18 num

```
// problem 7.18
d=1.2
i=1/1500
C=52
z=1.9-1/1
z1=acos(z)
x=3.142-z1
A=d*d*0.25*(x-(sin(2*x)/2))
P=d*x
m=A/P
Q=A*C*((m*i)^0.5)
disp(Q*1000,"the maximium discharge through the
  channel in litres/sec")
```

Chapter 8

Impact of jets

Scilab code Exa 8.1 num

```
// problem 8.1
V=25
F=300
g=9.81
p=1000
w=g*p
A=(F*g)/(w*V*V)
V1=35
F1=(w*A*V1*V1)/(g)
disp(F1,"force in N on the plate if the velocity of
    the jet is increased to 35 m/sec")
```

Scilab code Exa 8.2 num

```
// problem 8.2
d=0.05
V=15
g=9.81
```

```
p1=1000
w=g*p1
a=3.142*d*d/4
F=(w*a*V*V)/g
u=5
F1=(w*a*((V-u)^2))/g
disp(F,"force in N on plate if plate is stationary")
disp(F1,"force in N on plate if plate is moving in
    the direction of the jet")
```

Scilab code Exa 8.3 num

```
// problem 8.3
d=0.03
Fx=900
x=30
g=9.81
w=g*1000
a=3.142*d*d/4
V=((Fx*g)/(w*a*sind(x)*sind(x)))^0.5
Q=a*V
disp(Q*1000,"rate of flow in m3/sec")
```

Scilab code Exa 8.4 num

```
// problem 8.4
d=0.02
V=20
x=15
g=9.81
p1=1000
w=g*p1
a=3.142*d*d/4
```

```
W=(w*a*V*V)/(g*sind(x))
F1=(w*a*V*V)/(2*g)
disp(W,"weight of the plate in N")
disp(F1,"force in N required at the lower edge of
    the plate")
```

Scilab code Exa 8.5 num

```
// problem 8.5
d=0.05
V=20
y=120
x=180-y
g=9.81
p1=1000
w=g*p1
a=3.142*d*d/4
F=(w*a*V*V*(1+cosd(x)))/(g)
disp(F,"force in N exerted by the water jet")
```

Scilab code Exa 8.6 num

```
// problem 8.6
d=0.05
V=20
u=7
a=3.142*d*d/4
g=9.81
p1=1000
w=g*p1
F=(w*a*V*V)/g
F1=(w*a*((V-u)^2))/g
work=F1*u
```

```
disp(F,"force in N if plate is fixed ")
disp(F1,"force in N if plate is moving with a
   velocity of 7 m/sec")
disp(work,"work done per sec by the jet")
```

Scilab code Exa 8.7 num

```
// problem 8.7
W=58.86
d=0.02
V=5
z=0.15
g=9.81
p1=1000
w=g*p1
a=3.142*d*d/4
F=(w*a*V*V)/g
cog=0.1
x=30
P=(F*z)/cog
F1=((P*cog*(cosd(x)))+(W*cog*(sind(x))))
V1=((F1*g)/(w*a))^0.5
disp(V1,"velocity in m/sec of the jet if the plate
   is deflected through 30 degree")
```

Scilab code Exa 8.8 num

```
// problem 8.8
V=25
u=10
q=0.001
g=9.81
p1=1000
```

```
w=g*p1
x=180
u1=8
F1=(w*q/g)*V*(1-cosd(x))
F2=(w*q*((V-u)^2)*(1-cosd(x)))/(g*V)
F3=(w*q*(V-u1)*(1-cosd(x)))/g
disp(F3,F2,F1,"force of jet in N when,the cup is
    stationary ,the cup is moving with velocity of 10m
    /sec , series of cup with velocity of 8m/sec")
```

Scilab code Exa 8.9 num

```
// problem 8.9
x1=30
V1=30
Q=0.001
g=9.81
w=g*1000
Vf1=V1*sind(x1)
Vw1=V1*cosd(x1)
u=15
x2=120
y1=atand(Vf1/(Vw1-u))
Vr1=((Vf1*Vf1)+((Vw1-u)^2))^0.5
z=u*sind(x2)/Vr1
y2=60-asind(z)
V2=Vr1*sind(y2)/sind(x2)
Vw2=V2*cosd(x2/2)
W=(w*Q*(Vw1+Vw2)*u)/g
n=W*2/(V1*V1)
disp(n*100,W,y2,"angle of vane,work done of water
    entering the vane,efficiency")
```

Scilab code Exa 8.10 num

```
// problem 8.10
Q=0.283
d=0.05
x=170
u=48
g=9.81
p1=1000
w=g*p1
a=3.142*d*d/4
V1=Q/a
Vw1=V1
Vr1=V1-u
x1=0
Vr2=Vr1
Vw2=(Vr2*cosd(180-x))-u
Fx=(w*a*(V1-u)*(Vw1+Vw2))/g
P=Fx*u/1000
n=(P*1000*g*2)/(w*Q*V1*V1)
disp(n*100,P,Fx,"force exerted by the jet,power
   developed by the vane,efficiency")
```

Scilab code Exa 8.11 num

```
// problem 8.11
y1=30
y2=15
a=13*(10^-4)
x1=15
V1=60
Vf1=V1*sind(y2)
Vw1=V1*cosd(y2)
u=Vw1-(Vf1/tand(y1))
Vw2=u-(Vf1*cosd(y2)/sind(y1))
```

```
Vf2=(u-Vw2)*tand(y2)
V2=(Vf2*Vf2+Vw2*Vw2)^0.5
x2=atand(Vf2/Vw2)
g=9.81
p1=1000
w=g*p1
Fx=(w*a*V1*(Vw1-Vw2))/g
Fy=(w*a*V1*(V1*sind(y2)-V2*sind(x2)))/g
Fr=(Fx*Fx+Fy*Fy)^0.5
o=atand(Fy/Fx)
disp(o,Fr,x2,V2,u,"velocity of the vane,direction of
    velocity at exit,resultant force,angle between
    forces")
```

Scilab code Exa 8.12 num

```
// problem 8.12
V1=13
y1=30
y2=y1
u=4.5
g=9.81
p1=1000
w=g*p1
Q=0.001
x1=acosd(0.9394)
Vw1=V1*cosd(x1)
Vr1=(Vw1-u)/cosd(y1)
Vw2=Vr1*cosd(y1)-u
Vf2=Vr1*sind(y1)
V2=(Vf2*Vf2+Vw2*Vw2)^0.5
x2=atand(Vf2/Vw2)
W=(w*Q*(Vw1+Vw2)*u)/g
disp(W,x2,V2,x1,"direction of velocity, velocity of
    water at exit,direction of work,magnitude of work
```

```
    done per kg of water")
```

Scilab code Exa 8.13 num

```
// problem 8.13
V1=40
u=12
x1=20
x2=90
Vw1=V1*cosd(x1)
Vf1=V1*sind(x1)
y1=atand(Vf1/(Vw1-u))
Vr1=Vf1/sind(y1)
Vr2=0.9*Vr1
y2=acosd(u/Vr2)
W=1*Vw1*u
n=W/(V1*V1*0.5*1)
disp(n*100,W,y2,y1,"vane angle at the exit,work done
    on the vane per kg of water,efficiency")
```

Scilab code Exa 8.14 num

```
// problem 8.14 sce
d=0.05
V1=25
x1=30
x=50
x2=x1+x
g=10
p1=1000
a=3.142*d*d/4
w=g*p1
Fx=(w*a*V1*V1*(cosd(x1)-cosd(x2)))/g
```

```
Fy=(w*a*V1*V1*(sind(x1)-sind(x2)))/g
F=(Fx*Fx+Fy*Fy)^0.5
z=atand(-Fy/Fx)
disp(z,Fx,Fy,"resultant force,angle made by the
    resultant force with the horizontal")
```

Scilab code Exa 8.15 num

```
// problem 8.15
x1=0
x2=60
V1=30
V2=25
m=0.8
Fx=m*((V1*cosd(x1))-(V2*cosd(x2)))
Fy=m*((V1*sind(x1))-(V2*sind(x2)))
R=(Fx*Fx+Fy*Fy)^0.5
z=atand(-Fy/Fx)
disp(z,R,"magnitude and direction of resultant force
    ")
```

Chapter 9

Reciprocating pump

Scilab code Exa 9.1 num

```
// problem 9.1
D=0.15
s=0.25
N=50
Hs=5
Hd=5
n1=0.6
n2=0.78
g=9.81
w=g*1000
a=3.142*D*D/4
Fs=(w*a*Hs)/n1
Fd=(w*a*Hd)/n2
P=((Fs+Fd)*s*N)/(1000*60)
disp(P,"power required by the pump in Kw")
```

Scilab code Exa 9.2 num

```
// problem 9.2
D=0.18
s=0.36
Hs=3
Hd=45
N=50
n=0.85
a=3.142*D*D/4
Q=(2*a*s*N)/60
g=9.81
w=g*1000
P=w*Q*(Hs+Hd)/(n*1000)
disp(P,"power in kw required to drive the pump")
```

Scilab code Exa 9.3 num

```
// problem 9.3
D=0.15
s=0.3
Hs=3
Hd=30
n=0.8
a=3.142*D*D/4
N=60/60
w=9810
Q=0.62/60
Qth=(2*a*s*N)
slip=(Qth-Q)/Qth
power=(w*Qth*(Hs+Hd))/(1000*n)
disp(slip*100,power,"power in Kw required to drive
    the pump,percentage slip")
```

Scilab code Exa 9.4 num

```
// problem 9.4
D=0.15
s=0.3
N=50/60
H=25
Qact=0.0042
Ld=22
d=0.1
a=3.142*D*D/4
Qth=a*s*N
w=9810
power=w*Qth*H/1000
slip=(Qth-Qact)/Qth
W=2*3.142*N
a1=3.142*d*d/4
g=9.81
Had=(Ld*a*W*W*s)/(g*a1*2)
disp(Had,slip*100,power,Qth,"theoritical discharge,
   theoritical power,percentage slip,acceleration
   head")
```

Scilab code Exa 9.5 num

```
// problem 9.5
s=0.15
Ls=7
ds=0.075
N=75/60
Hs=2.5
z=16/9
f=0.01
W=2*3.142*N
g=9.81
Has=Ls*z*W*W*ds/g
H=Hs+Has
```

```
H1=Has-Hs
Hfs=(4*f*Ls/(ds*2*g))*((z*W*ds)^2)
H2=Hfs+Hs
disp(H2,H1,H,"pressure head:beginningof suction
   stroke,end of the suction stroke,middle of the
   suction stroke")
```

Scilab code Exa 9.6 num

```
// problem 9.6
D=0.08
s=0.15
Hs=3
ds=0.03
g=9.81
Ls=4.5
p=78.86*(1000)
w=9810
W=2*3.142/60
z=(D/ds)^2
Hsep=p/w
Habs=10.3-Hsep
Has=Hsep-Hs
N=((Has*g*2)/(z*W*W*s*Ls))^0.5
disp(N,"maximium speed in rpm at which may run
   without separation")
```

Scilab code Exa 9.7 num

```
// problem 9.7
Hs=5
Ls=10
D=0.15
```

```
d=0.1
N=30/60
s=0.15
g=9.81
W=2*3.142*N
w=9810
ha=10.3
z=(D/d)^2
H=(Ls*z*W*W*s/g)
Ph=Hs+H
Phabs=ha-Ph
f=0.01
Hfs=(4*f*Ls/(d*2*g))*((z*W*s)^2)
H1=Hs+Hfs
H1abs=ha-H1
H2=Hs-H
H2abs=ha-H2
Hd=15
Ld=25
H11=(Ld*z*W*W*s/g)
H12=H11+Hd
H12abs=ha+H12
Hfd=(4*f*Ld/(d*2*g))*((z*W*s)^2)
H22=Hd+Hfd
H22abs=ha+H22
H3=Hd-H11
H3abs=ha+H3
a=3.142*D*D/4
Q=a*s*2*N
power=(w*Q*(Hs+Hd+(0.6666*Hfs)+Hfd*0.6666))/1000
disp(H2abs,H1abs,"pressure head at middle and end of
    suction stroke")
disp(H3abs,H22abs,H12abs,"pressure head at beginning
    ,middle,end of suction stroke")
disp(power,"power in Kw required to drive the pump")
```

Chapter 10

Centrifugal pump

Scilab code Exa 10.1 num

```
// problem 10.1
N=900/60
x1=90
D1=0.2
D2=0.4
n=0.7
g=9.81
u1=3.142*D1*N
u2=2*u1 // as D2=2D1
y1=20
Vf1=u1*tand(y1)
Vr1=Vf1/sind(y1)
Vf2=Vf1
Vr2=Vr1
x=(Vr2*Vr2-Vf1*Vf1)^0.5
Vw2=u2-x
B1=0.02
Q=3.142*D1*B1*Vf1
H=Vw2*u2/g
w=9810
P=(w*Q*Vw2*u2)/(g*1000)
```

```
inputpower=(w*Q*H)/(1000*n)
disp(inputpower,P,H,Q,"discharge through the pump,
    heat developed,power in Kw at outlet,input power
    if overall efficiency is 70%")
```

Scilab code Exa 10.2 num

```
//problem 10.2
Hs=2
Hd=20
Hfs=1
Hfd=5
Q=1/60
N=1450/60
ds=0.1
dd=ds
n=0.75
g=9.81
w=9810
a=3.142*ds*ds/4
Vs=Q/a
Vd=Vs
Ht=Hs+Hd+Hfs+Hfd+(Vs*Vs/(2*g))+(Vd*Vd/(2*g))
Pi=(w*Q*Ht)/(n*1000)
Ns=((N*(Q^0.5))/(Ht^0.75))*60
disp(Ns,Pi,Ht,"total head developed by the pump,
    power input to the pump,specific speed of pump in
     r.p.m")
```

Scilab code Exa 10.3 num

```
// problem 10.3
d2=0.6
```

```
Q=20/60
N=1400/60
V1=2.8
g=9.81
y2=30
w=9810
Vf1=V1
Vf2=V1
u2=3.142*d2*N
x=Vf2/tand(y2)
Vw2=u2-x
Hm=Vw2*u2/g
P=(w*Q*Hm)/1000
disp(P,Hm,"head developed, pump power")
```

Scilab code Exa 10.4 num

```
// problem 10.4
N=1450/60
N1=1650/60
H=12
P=6
H1=H*((N1/N)^2)
P1=P*((N1/N)^3)
disp(P1,H1,"head developed and power required if pump runs at 1650 r.p.m")
```

Scilab code Exa 10.5 num

```
// problem 10.5
Q=0.03
Hs=18
d=0.1
```

```
l=90
n=0.8
w=9810
a=3.142*d*d/4
f=0.04
g=9.81
Vd=Q/a
H1=(4*f*l*Vd*Vd)/(d*2*g)+(Vd*Vd/(2*g))
Hm=Hs+H1
P=(w*Q*Hm)/(n*1000)
disp(P,"power required to drive the pump")
```

Scilab code Exa 10.6 num

```
// problem 10.6
Q=0.04
Hm=30
n=0.75
w=9810
p=w*Q*Hm/1000
P=p/n
disp(P,p,"output power of the pump,power required to
    drive the motor")
```

Scilab code Exa 10.7 num

```
// problem 10.7
Q=1.8/60
d=0.1
n=0.72
Hs=20
w=9810
Hl=8
```

```
Hm=Hs+Hl
p=(w*Hm*Q)/1000
P=p/n
disp(P,p,"water power required to the pump,power
   required to run the pump")
```

Scilab code Exa 10.8 num

```
// problem 10.8
d2=0.6
Q=15/60
N=1450/60
V1=2.6
g=9.81
y2=30
w=9810
Vf1=V1
Vf2=V1
u2=3.142*d2*N
x=Vf2/tand(y2)
Vw2=u2-x
Hm=Vw2*u2/g
P=(w*Q*Hm)/1000
disp(P,Hm,"head developed , pump power")
```

Scilab code Exa 10.9 num

```
// problem 10.9
Q=0.05
p=392.4*1000
n=0.65
s=0.8
w1=9810
```

```
Hw=p/w1
Hoil=p/(w1*s)
Pw=(w1*Q*Hw)/(n*1000)
Poil=(w1*s*Q*Hoil)/(n*1000)
disp(Pw,Poil,"power in Kw to drive the pump with
    water and oil of s,p=0.8")
```

Scilab code Exa 10.10 num

```
// problem 10.10
Q=0.118
N=1450/60
Hm=25
d2=0.25
B2=0.05
n=0.75
g=9.81
u2=3.142*d2*N
Vf2=Q/(3.142*d2*B2)
Vw2=g*Hm/(n*u2)
y2=atand(Vf2/(u2-Vw2))
disp(y2,"vane angle in degree at the outer
    nperiphery of the impeller")
```

Scilab code Exa 10.11 num

```
// problem 10.11
Hm=14.5
N=1000/60
y2=30
d2=0.3
B2=0.05
g=9.81
```

```
n=0.95
u2=3.142*d2*N
Vw2=g*Hm/(n*u2)
Vf2=(u2-Vw2)*tand(y2)
Q=3.142*d2*B2*Vf2
disp(Q*1000,"discharge of pump in m3/sec if
   manometric efficiency if 95%")
```

Scilab code Exa 10.12 num

```
// problem 10.12
d2=1.2
N=200/60
Q=1.88
Hm=6
y2=26
g=9.81
Vf2=2.5
d1=0.6
u2=3.142*d2*N
Vw2=u2-(Vf2/tand(y2))
n=g*Hm/(Vw2*u2)
z1=(3.142*d2/60)^2
z2=(3.142*d1/60)^2
N1=(Hm*2*g/(z1-z2))^0.5
disp(n*100,N1,"least speed to start pump,manometric
   efficiency")
```

Scilab code Exa 10.13 num

```
// problem 10.13
Q=0.125
Hm=25
```

```
N=660/60
d2=0.6
d1=d2*0.5
a=0.06
y2=45
g=9.81
u2=3.142*d2*N
u1=u2*0.5
Vf2=Q/a
Vw2=u2-(Vf2/tand(y2))
n=g*Hm/(Vw2*u2)
Vf1=Q/(a)
y1=atand(Vf1/u1)
disp(y1,n*100,"manometric efficiency ,vane angle at
    inlet")
```

Scilab code Exa 10.14 num

```
// problem 10.14
n=3
d2=0.4
B2=0.02
y2=45
da=0.1
nm=0.9
w=9810
no=0.8
g=9.81
N=1000/60
Q=0.05
Vf2=Q/(3.142*d2*nm*B2)
u2=3.142*d2*N
Vw2=u2-(Vf2/tand(y2))
Hm=nm*Vw2*u2/g
Ht=n*Hm
```

```
P=w*Q*Ht/1000
Ps=P/no
disp(Ps,"shaft power in Kw")
```

Scilab code Exa 10.15 num

```
// problem 10.15
n=6
Q=0.12
p=5003.1*1000
N=1450/60
w=9810
Ht=p/w
h=Ht/n
Ns=(N*(Q^0.5)/(h^0.75))*60
disp(Ns,"radial impeller would be selected")
```

Scilab code Exa 10.16 num

```
// problem 10.16
sg=1.08
w=9810*sg
Q=0.3
H=12
no=0.75
P=w*Q*H/(no*1000)
p=w*H
disp(p,P,"power in Kw required by the pump,pressure
    developed by the pump in  N/m2")
```

Scilab code Exa 10.17 num

```
// problem 10.17
d1=0.3
N1=2000/60
Q1=3
Hm1=30
Q2=5
N2=1500/60
Ht=200
Hm2=((N2/N1)*((Q2/Q1)^0.5)*(Hm1^0.75))^1.3333
n=Ht/Hm2
d2=((Hm2/Hm1)^0.5)*(N1/N2)*d1
disp(d2*100,n,"number of stages and diameter of each
    impeller in cm")
```

Chapter 11

Impulse turbine

Scilab code Exa 11.1 num

```
// problem 11.1
P=8820*1000
N=600/60
H=500
Cv=0.97
Cu=0.46
no=0.85
w=9810
g=9.81
Q=P/(no*w*H)
V1=Cv*((2*g*H)^0.5)
u=Cu*V1
D=u/(3.142*N)
d=D/15
a=3.142*d*d/4
n=Q/(a*V1)
n1=round(n+1)
disp(n1,d*100,D,Q,"discharge in m3/sec,wheel
   diameter in m, jet diameter in cm, number os jets
   ")
```

Scilab code Exa 11.2 num

```
// problem 11.2
H=46
Q=1
u1=15
y=165
y2=180-y
Cv=0.975
g=9.81
V1=((2*g*H)^0.5)
Vw1=V1
Vr1=V1-u1
Vr2=Vr1
Vw2=(Vr2*(cosd(y2)))-u1
w=9810
P=(w*Q*(Vw1+Vw2)*u1)/(g*1000)
n=P*1000/(w*Q*H)
disp(n*100,P,"power developed in Kw and efficiency
   of the wheel")
```

Scilab code Exa 11.3 num

```
// problem 11.3
H=340
P=4410*1000
N=500/60
Cv=0.97
no=0.86
w=9810
g=9.81
Q=P/(w*H*no)
```

```
V1=Cv*(sqrt(2*g*H))
u=0.45*V1
D=u/(3.142*N)
a=Q/V1
disp(a,D,"mean diameter in m,jet area in m2")
```

Scilab code Exa 11.4 num

```
// problem 11.4
H=45
Q=50/60
u1=12.5
y=160
y2=180-y
Cv=0.97
g=9.81
V1=Cv*((2*g*H)^0.5)
Vw1=V1
Vr1=V1-u1
Vr2=Vr1
Vw2=Vr2*(cosd(y2))-u1
w=9810
P=(w*Q*(Vw1+Vw2)*u1)/(g*1000)
nh=(2*u1*(Vw1+Vw2))/(V1*V1)
disp(nh*100,P,"power developed in Kw and hydraulic
    efficiency")
H1=50
V11=Cv*((2*g*H1)^0.5)
Vw11=V11
Vr11=V11-u1
Vr21=Vr11
Vw21=Vr21*(cosd(y2))-u1
w=9810
P=(w*Q*(Vw11+Vw21)*u1)/(g*1000)
disp(P,"Power developed in Kw if head is increased
```

```
    to 50")
```

Scilab code Exa 11.5 num

```
// problem 11.5
H=50
Q=1.2
u1=18
y=160
y2=180-y
Cv=0.94
g=9.81
V1=Cv*((2*g*H)^0.5)
Vw1=V1
Vr1=V1-u1
Vr2=Vr1
Vw2=Vr2*(cosd(y2))-u1
w=9810
P=(w*Q*(Vw1+Vw2)*u1)/(g*1000)
n=P*1000/(w*Q*H)
disp(n*100,P,"power developed in Kw and efficiency
    of the wheel")
```

Scilab code Exa 11.6 num

```
// problem 11.6
D=1
N=1000/60
H=700
y=165
y2=180-y
Q=0.1
Cv=0.97
```

```
g=9.81
u=D*3.142*N
V1=Cv*(sqrt(2*g*H))
nh=(2*u*(V1-u)*(1+(cosd(y2))))/(V1*V1)
disp(nh*100,"hydraulic efficiency of the wheel")
```

Scilab code Exa 11.7 num

```
// problem 11.7
Hg=500
hf=Hg/3
H=Hg-hf
Q=2
y=165
y2=180-y
g=9.81
w=9810
Cv=1
V1=Cv*(sqrt(2*g*H))
u=0.45*V1
Vr1=V1-u
Vw1=V1
Vr2=Vr1
Vw2=(Vr2*(cosd(y2)))-u
W=w*Q*(Vw1+Vw2)*u/g
P=W/1000
nh=2*u*(Vw1+Vw2)/(V1*V1)
disp(nh*100,P,"power given by the water to the
    runner in Kw,Hydraulic efficiency")
```

Scilab code Exa 11.8 num

```
// problem 11.8
```

```
L=1600
H=550
Dp=1.2
d=0.18
f=0.006
Cv=0.97
g=9.81
V1=Cv*(sqrt(2*g*H))
a=3.142*d*d/4
Q=a*V1
w=9810
P=(w*Q*V1*V1)/(2*g*1000)
ap=3.142*Dp*Dp/4
Vp=Q/ap
Hf=(4*f*L*Vp*Vp)/(Dp*2*g)
Tp=4*w*Q*(H+Hf)/1000
disp(Tp,P,"power to each jet in Kw,total power at
    reserviour i Kw")
```

Scilab code Exa 11.9 num

```
// problem 11.9
Q=4
H=250
L=3000
n1=4
n=0.91
nh=0.9
Cv=0.975
f4=0.0045
hf=H-H*n
Hn=H-hf
g=9.81
w=9810
V1=Cv*(sqrt(2*g*Hn))
```

```
Pw=w*Q*V1*V1/(2*g*1000)
Pt=nh*Pw
q=Q/n1
d=sqrt(4*q/(3.142*V1))
D=((f4*L*16*16)/(2*g*3.142*3.142*hf))^0.2
disp(D,d,Pt,"power developed by turbine in Kw,
    diameter jet and diameter of pipeline")
```

Chapter 12

Reaction turbine

Scilab code Exa 12.1 num

```
// problem 12.1
D1=0.6
D2=0.3
x2=90
B1=0.15
N=300/60
x1=15
Vf1=3
Vf2=Vf1
u1=3.1428*D1*N
u2=3.142*D2*N
Vw1=Vf1/tand(x1)
y1=atand(Vf1/(Vw1-u1))
Q=3.142*D1*B1*Vf1
w=9810
g=9.81
P=w*Q*Vw1*u1/(g*1000)
disp(P,y1,"blade angles , Power developed in Kw")
```

Scilab code Exa 12.2 num

```
// problem 12.2
D1=1
N=200/60
B1=0.15
Vf1=3
Vf2=Vf1
x2=90
Q=3.142*D1*B1*Vf1
u1=3.142*D1*N
Vw1=u1
w=9810
g=9.81
P=(w*Q*Vw1*u1)/(g*1000)
H=(Vw1*u1/g)+(Vf2*Vf2/(2*g))
nh=Vw1*u1/(g*H)
disp(nh*100,P,"power developed in Kw,hydraulic
    efficiency")
```

Scilab code Exa 12.3 num

```
// problem 12.3
D1=0.75
D2=0.5
x1=20
Vf1=3
Vf2=3
B1=0.15
N=250/60
u1=3.142*D1*N
u2=3.142*D2*N
Vw1=Vf1/tand(x1)
y1=atand(Vf1/(u1-Vw1))
y2=atand(Vf2/u2)
```

```
Q=3.142*D1*B1*Vf1
w=9810
g=9.81
P=w*Q*Vw1*u1/(g*1000)
H=(Vw1*u1/g)+(Vf2*Vf2/(2*g))
nh=Vw1*u1/(g*H)
disp(nh*100,P,y2,y1,"hydraulic efficiency ,power
    developed in Kw, blade angle at inlet and outlet")
```

Scilab code Exa 12.4 num

```
// problem 12.4
H=150
Q=6
N=400/60
D1=1.2
x1=20
x2=90
B1=0.1
u1=3.142*D1*N
Vf1=Q/(3.142*D1*B1)
Vw1=Vf1/tand(x1)
Vw2=0
w=9810
g=9.81
P=w*Q*Vw1*u1/(g*1000)
disp(P,Vw2,Vw1,"whirl component at inlet and outlet ,
    power developed in Kw")
```

Scilab code Exa 12.5 num

```
// problem 12.5
D1=0.76
```

```
D2=0.5
x1=20
Vf1=4
Vf2=Vf1
B1=0.15
N=300/60
u1=3.142*D1*N
u2=3.142*D2*N
Vw1=Vf1/tand(x1)
y1=atand(Vf1/(u1-Vw1))
y2=atand(Vf2/u2)
Q=3.142*D1*B1*Vf1
w=9810
g=9.81
P=w*Q*Vw1*u1/(g*1000)
disp(P,y2,y1,"blade angle at inlet and outlet,power
    developed in Kw")
```

Scilab code Exa 12.6 num

```
// problem 12.6
no=0.8
P=147*1000
H=10
g=9.81
u1=0.95*(sqrt(2*g*H))
Vf1=0.3*(sqrt(2*g*H))
N=160/60
Vw2=0
nh=(H-(0.2*H))/H
Vw1=nh*g*H/u1
x1=atand(Vf1/Vw1)
y1=atand(Vf1/(u1-Vw1))
D1=u1/(3.142*N)
w=9810
```

```
p=147*1000
Q=p/(w*H*no)
B1=Q/(3.142*D1*Vf1)
disp(B1*100,D1,y1,x1,"guide blade angle,wheel vane
    angle,diameter of wheel,width of wheel at inlet
    in cm")
```

Scilab code Exa 12.7 num

```
// problem 12.7
sp=25*(10^6)
H=40
no=0.9
P=25*1000
g=9.81
u1=2*(sqrt(2*g*H))
Vf1=0.6*(sqrt(2*g*H))
w=9810
Q=sp/(w*no*H)
De=(Q*4/(3.142*Vf1*(1-(0.35^2))))^0.5
Db=0.35*De
N=u1*60/(3.142*De)
Ns=N*(P^0.5)/(H^1.25)
disp(Ns,N,Db,De,"diameter of runner and boss, speed
    and specific speed of runner in r.p.m")
```

Scilab code Exa 12.8 num

```
// problem 12.8
D=4.5
d=2
P=20608
N=140/60
```

```
H=22
nh=0.94
w=9810
g=9.81
no=0.85
Q=P*1000/(w*no*H)
Vf1=Q*4/(3.142*((D^2)-(d^2)))
u1=3.142*D*N
Vw1=nh*g*H/u1
x1=atand(Vf1/Vw1)
disp(x1,Q,"discharge through the turbine,guide blade
    angle at inlet")
```