Scilab Textbook Companion for Principles Of Fluid Mechanics by M. K. Natarajan [1]

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Book Description

Title: Principles Of Fluid Mechanics

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

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

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

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

Contents

List of Scilab Codes

Chapter 1

Basic Concepts

Scilab code Exa 1.1 Example 1

```
clc
//Initialization of variables
weight = 9800 //Kg
g=9.81  //m/s^2
a=2 //m/s^2
//calculations
m=weight/g
Wm=m*a
//results
printf("Density on earth =%.2f Kg/m^3",m)
printf("\n Weight on moon = %.2f N",Wm)
printf("\n Density on moon remains unchanged and is
    equal to %.2f Kg/m^3",m)
```

Scilab code Exa 1.2 Example 2

```
clc
//Initialization of variables
```

```
w=150 //N
theta=30 //degrees
l=0.8 //m
b=0.8 //m
dy=0.12 //cm
v=20 //cm/s
//calculations
Tau=w*sind(theta) /(l*b)
rd=v/dy
vis=Tau/rd
//results
printf("Viscosity of the fluid = %.2f N s/m^2",vis)
```

Scilab code Exa 1.3 Example 3

```
clc
clear
//Initialization of variables
vis=2.5/10 //N s/m^2
D=15 //cm
N=180
dy=0.0001 //m
l=0.15 //m
b=0.25 //m
r=0.152 //m
//calculations
dv=%pi *D*N/60/100
Tau=vis*dv/dy
Tor=Tau*%pi*l*b*r/2
P=Tor*2*%pi*N/60
//results
printf("Power required = %d W",P)
disp("The answer is a bit different due to rounding off error in textbook.")
```

Scilab code Exa 1.4 Example 4

```
clc
//Initialization of variables
w=1 //rad/s
T=0.4 //N/m^2
//calculations
mu=T/tan(w)
//results
printf("Viscosity = %.2f N s/m^2",mu)
```

Scilab code Exa 1.6 Example 5

```
clc
//Initialization of variables
d=0.05*10^-3 //m
T=72*10^-3 //N/m
P=101 //kN/m^2
//calculations
Pi=P*1000 + 2*T/(d/2)
//results
printf("Pressure = %.2f kN/m^2",Pi/1000)
```

Scilab code Exa 1.7 Example 6

```
clc
//Initialization of variables
gam=981 //dyn/cm^2
sigma=72 //dyn/cm
```

```
theta=0 //degrees
d=0.5 //cm
depth=90 //cm
//calculations
h=4*sigma*cosd(theta)/(gam*d)
Td=depth-h
//results
printf("True depth = %.3f cm",Td)
```

Chapter 2

Fluid Statics

Scilab code Exa 2.1 Example 1

```
clc
//Initialization of variables
h1=1.5 //m
h2=2 //m
g1=800 //kg/m^3
g2=1000 //kg/m^3
g=9.81
//calculations
P=h1*g*g1 + h2*g*g2
//results
printf("Pressure at the bottom of the vessel = %.2f
   kN/m^2",P/1000)
```

Scilab code Exa 2.2 Example 2

```
clc
//Initialization of variables
depth=8000 //m
```

```
sw=10.06 //kN/m^3
BM=2.05*10^9 //N/m^2
//calculations
g=sw*10^3 /(1- sw*10^3 *depth/BM)
Ph=2.3*BM*log10(BM/(BM-depth*9.81*1025))
//results
printf("Specific weight = %.2f kN/m^2",g/1000)
printf("\n Pressure at depth h = %.2f MN/m^2",Ph
    /10^6)
```

Scilab code Exa 2.3 Example 3

```
clc
//Initialization of variables
Patm=101.3/9.81 //m of water
x1=0.45 //m
x2=0.3 //m
s1=920 //Kg/m^3
s2=13600 //Kg/m^3
g=9.81 //m/s^2
//calculations
Pa=s1*x1*g + s2*x2*g
Pa2=Pa/(1000*g)
Pa3=Pa/(s2)
//results
printf("Pressure at A = %.1f kPa",Pa/1000)
printf("\n Pressure at A = %.3f m of water",Pa2)
printf("\n Pressure at A = %.3f m of mercury",Pa3)
printf("\n Pressure at A = %.3f m of water absolute"
    ,Pa/1000 +101.3)
printf("\n Pressure at A = %.3f m of mercury",Pa2
    +10.3)
```

Scilab code Exa 2.4 Example 4

```
clc
//Initialization of variables
sg=1.25
d=0.5 //m
d2=13.5*10^-2 //m
sw=9.81 //kN/m^2
//calculations
sl=sg*sw
sm=13.6*sw
Pa=sl*d - sm*d2
//results
printf("Pressure at A = %.2f kN/m^2 vacuum ",Pa)
```

Scilab code Exa 2.5 Example 5

```
clc
//Initialization of variables
s1=0.85
s2=13.6
z1=30
z2=15
z3=20
z4=35
z5=60
//calculations
dHa=s1*(z1+z5+z3-z4) +s2*z4 -z3+s2*z2-s1*(z1+z2)
Pd=1000*9.81*dHa/100
//results
printf("Pressure difference = %.2f kN/m^2",Pd/1000)
```

Scilab code Exa 2.6 Example 6

```
clc
//Initialization of variables
P=450 //kN/m^2
alt=2000 //m
r=610 //mm of mercury
//calculations
Pat=760-r
Pat2=Pat*13.6*9.81*10^-3
Pg=Pat2+P
//results
printf("Gauge reading = %.2f kN/m^2",Pg)
```

Scilab code Exa 2.7 Example 7

```
clc
//Initialization of variables
g=9.81 //kN/m^2
hc=16.25 //m
l=1.5 //m
b=2.5 //m
f=0.3
Pi=50 //kN
//calculations
P=g*hc*l*b
Preq=Pi+f*P
//results
printf("Force required to lift the gate = %.2f kN",
    Preq)
```

Scilab code Exa 2.8 Example 8

```
clc
//Initialization of variables
```

```
a=6 //m
b=8 //m
//calculations
Ixy=9/32 *b^4 /4
xp= Ixy/(2/3 *b *1/2 *a*b)
ICG=1/36 *a*b^3
yp=2/3*b + ICG/(2/3 *b* 1/2 *a*b )
//results
printf("The coordinates of centre of pressure are (%.2f ,%d)",xp,yp)
```

Scilab code Exa 2.9 Example 9

```
clc
//Initialization of variables
z=1.2 //m
y=1 //m
//calculations
hp=0.6 + 1/12 *y*z^3 /(0.6*y*z)
//results
printf("Position of hinge = %.1f m",hp)
```

Scilab code Exa 2.10 Example 10

```
clc
//Initialization of variables
r=0.75 //m
gam=8 //kN/m^3
//calculations
hp=3*%pi*r/16
P=gam*2/3 *r^3
//results
printf("Total pressure location = %.3f m",hp)
```

```
printf("\n Total pressure = %.2f kN",P)
```

Scilab code Exa 2.11 Example 11

```
clc
//Initialization of variables
l=3 //m
b=2 //m
h1=0.75 //m
h2=1 //m
sg=0.9
//calculations
IP=sg*9.81*h2
F1=0.5*IP*h2
F2=IP*h1
F3=0.5*(9.81*h1)*h1
F=l*(F1+F2+F3)
ybar= (F1*(h1+ 1/3) + F2* h1/2 + F3* h1/3)/(F1+F2+F3)
//results
printf("Total force = %.2f kN",F)
printf("\n Location = %.3f m from the base",ybar)
```

Scilab code Exa 2.12 Example 12

```
clc
//Initialization of variables
g=1000*9.81 //kg/m^3
hc=20 //m
Ax=40*1 //m^2
y1=0 //m
y2=40 //m
//calculations
```

```
Fx=g*hc*Ax
function[f] =fy(y)
    f=(12*y)^(1/3)
endfunction
Fy=intg(y1,y2,fy)
Fy=g*Fy(1)
F=sqrt(Fx^2 +Fy^2)
//results
printf("Net force = %d kN",F/1000)
//The answer is a bit different due to rounding off
   error in the textbook
```

Scilab code Exa 2.13 Example 13

```
clc
//Initialization of variables
g=9.81 //kN/m^2
hc=1 //m
l=3 //m
b=0.5 //m
//calculations
Ax=l*b //m^2
Fx=g*hc*Ax
Fz=g*(0.5* %pi/4 *b^2)*l
F=sqrt(Fx^2 + Fz^2)
theta=atand(Fz/Fx)
//results
printf("Magintude of resultant force = %.2f kN",F)
printf("\n Directionn of the resultant force = %.1f
   deg",theta)
```

Scilab code Exa 2.14 Example 14

```
clc
//Initialization of variables
r1=920 //kg/m^3
r2=1030 //kg/m^3
//calculations
VtbyV2=r2/r1
V1byV2=VtbyV2-1
V1byVt=1/(1+1/V1byV2)
//results
printf("fraction = %.3f ",V1byVt)
```

Scilab code Exa 2.15 Example 15

```
clc
//Initialization of variables
d=3 //m
rh1=1.19 //kg/m^3
rh2=0.17 //kg/m^3
g=9.81 //m/s^2
//calculations
pay=(rh1-rh2)*g*%pi/6 *d^3
//results
printf(" Pay load = %.2f N",pay)
```

Scilab code Exa 2.16 Example 16

```
clc
//Initialization of variables
x=poly(0,"x")
//calculations
y=6*x^2 -6*x+1
z=roots(y)
//results
```

```
printf("For stability , s must be greater than %.2f
   and less than %.2f and must be less than 1",z(1),
   z(2))
```

Scilab code Exa 2.17 Example 17

```
clc
//Initialization of variables
ax=1.5 //m/s^2
g=9.81 //m/s^2
//calculations
alpha=atand(ax/g)
//results
printf("The interface is inclined at %.2f degrees
   with the horizontal",alpha)
```

Scilab code Exa 2.18 Example 18

```
clc
//Initialization of variables
d=10 //cm
h=25 //cm
hw=15 //cm
g=9.81 //m/s^2
//calculations
z=d^2 *d*2/d^2
w=sqrt(z*2*g/(d/2)^2 *100)
N=w/(2*%pi) *60
//results
printf("Speed of rotation = %d rpm",N)
```

Scilab code Exa 2.19 Example 19

```
clc
//Initialization of variables
dia=1 //m
h=3 //m
rho=1000 //kg/m^3
N=80 //rpm
g=9.81 //m/s^2
//calculation
w=2*%pi*N/60
function y = fun(r)
    y=0.5*rho*w^2 *r^3 *2*%pi
endfunction
vec=intg(0,dia/2,fun)
Pt=vec(1) + %pi/4 *dia^2 *(h-dia)*rho*g
//results
printf("Total pressure on base = %.2f kN",Pt/1000)
```

Chapter 3

Conservation Principle of Mass

Scilab code Exa 3.3 Example 1

```
clc
//Initialization of variables
d1=60 //cm
V1=45 //cm/s
d2=90 //cm
//calculations
V2=V1*d1^2 /d2^2
Q=%pi/4 *d1^2 *V1 *10^-6
//results
printf("Velocity at point 2 = %d cm/s",V2)
printf("\n FLow rate = %.4f m^3/s",Q)
```

Scilab code Exa 3.4 Example 2

```
clc
//Initialization of variables
dn1=4 //cm
v1=300 //cm/s
```

```
dn2=2.5 //cm
//calculations
v2=v1*dn1/dn2
//results
printf("Velocity = %.1f m/s",v2/100)
```

Chapter 4

Conservation Principle of Momentum

Scilab code Exa 4.1 Example 1

```
clc
//Initialization of variables
Q=0.2 //m^3/s
v=30 //m/s
angle=120 //degrees
rho=1000 //kg/m^3
//calculations
Rx=rho*Q*(v-v*cosd(angle))
Ry=rho*Q*v*sind(angle)
R=sqrt(Rx^2 +Ry^2)
//results
printf("Resultant force = %.2f kN",R/1000)
```

Scilab code Exa 4.3 Example 2

```
clc
```

```
//Initialization of variables
angle =45 //degrees
p1=150*10^3 //N/m^2
Q=0.5 //m^3/s
d1=60 //cm
d2=30 //cm
rho=1000 //kg/m^3
g=9.81 //m/s^2
//calculations
V1=Q/(%pi/4 *(d1/100)^2)
V2=V1*(d1/d2)^2
P2=rho*g*(p1/(rho*g) + V1^2 /(2*g) -V2^2 /(2*g))
Rx=p1*%pi/4*(d1/100)^2 - P2*%pi/4 *(d2/100)^2 *cosd(angle) -rho*Q*(V2*cosd(angle) -V1)
Ry=P2*%pi/4 *(d2/100)^2 *sind(angle) + rho*Q*(V2*sind(angle))
R=sqrt(Rx^2 + Ry^2)
//results
printf("resultant force = %.2f kN",R/1000)
```

Scilab code Exa 4.4 Example 3

```
clc
//Initialization of variables
Q=20*10^3 //cc/s
depth=4 //m
d=5 //cm
g=9.81 //m/s^2
rho=10^3 //kg/m^3
//calculations
V1= Q/(%pi/4 *d^2) /100
V2= sqrt(2*g*(V1^2/(2*g) + depth))
W=rho*Q*(V2-V1)/10^6
//results
printf("weight of water = %d N",W)
```

Scilab code Exa 4.5 Example 4

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
V=50 //m/s
u=20 //m/s
A=6/10^4 //m^2
angle=180 //degrees
//calculations
Vr=V-u
rq=rho*A*Vr
Rx=-rq*(Vr*cosd(angle) - Vr)
Rx2=-rho*A*V*(Vr*cosd(angle) -Vr)
power=Rx2*u
//results
printf("Force exetred on fluid = %d N",Rx)
printf("\n Force transferred in case 2 = %d N",Rx2)
printf("\n Power transferred in case 2 = %d kW",
   power/1000)
```

Scilab code Exa 4.6 Example 5

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
Vr=10 //m/s
u=8.5 //m/s
A=250/10^4 //m^2
```

```
//calculations
V=Vr-u
Q=A*Vr
R=rho*Q*V
P=R*u
eth=1/(1+ V/(2*u))
//results
printf("Power required = %.3f kW",P/1000)
printf("\n Efficiency of jet propulsion = %.2f
   percent",eth*100)
```

Scilab code Exa 4.7 Example 6

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
v1=20 //m/s
v2=5 //m/s
r1=50/100 //cm
r2=30/100 //cm
a1=20 //degrees
a2=80 //degrees
N=300 //rpm
Q=5 //m^3/s
//calculations
u1=%pi*2*r1*N/60
u2=%pi*2*r2*N/60
T=rho*Q*(r1*v1*cosd(a1) - r2*v2*cosd(a2))
H=1/g *(u1*v1*cosd(a1) - u2*v2*cosd(a2))
power=rho*g*Q*H
//results
printf("torque = %d N m",T)
printf("\n Heat = %.1f m",H)
printf("\n Power = %d kW",power/10^3)
```

```
//The answers given in textbook are a bit different
   due to rounding off error
```

Scilab code Exa 4.8 Example 7

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
d1=0.05 //m
d2=0.3 //m
N=1800 //rpm
Q=0.425/60 //m^3/s
//calculations
u1=%pi*d1*N/60
u2=%pi*d2*N/60
T=rho*Q*(d2*u2 - d1*u1)/2
//results
printf("Torque supplied = %.1f Nm",T)
```

Chapter 5

Conservation Principle of Energy

Scilab code Exa 5.1 Example 1

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
z2=0 //m
z1=8 //m
V2=5 //m/s
V1=3 //m/s
//calculations
Hs=(z2-z1) + (V2^2 -V1^2)/(2*g)
//results
printf("Work done by fluid = %.3f J/N",Hs)
```

Scilab code Exa 5.2 Example 2

```
clc
```

```
clear
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
P1=80*10^3 //N/m^2
P2=12*10^6 + 101300 //N/m^2
Hq=-400 //J/N
//calculations
g1=g*rho
Hs= -Hq+ (P2-P1)/(g1)
//results
printf("Energy added by pump = %d J/N",Hs)
disp("The answer given in textbook is wrong. Please verify using a calculator")
```

Scilab code Exa 5.3 Example 3

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
d1=15 //cm
d2=10 //cm
V1=2.4 //m/s
P1=450*10^3 //N/m^2
rho2=900 //kg/m^3
//calculations
V2=d1^2 /d2^2 *V1
P2=g*rho2*(P1/(rho2*g) + V1^2 /(2*g) - V2^2 /(2*g))
Q=%pi/4*(d2/100)^2 *V2
//results
printf("Pressure at 2 = %.2f kN/m^2",P2/1000)
printf("\n Flow rate = %.4f m^3/s",Q)
//The answer given in textbook is wrong. Please verify it.
```

Scilab code Exa 5.4 Example 4

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
z=10 //m
//calculations
PE=g*rho*%pi*z^2 /2
//results
printf("Work obtained = %.2e J",PE)
```

Scilab code Exa 5.6 Example 5

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
d1=7.5 //cm
d2=3 //cm
P1=300+101.3 //kPa
P2=25 //kPa
//calculations
V1=sqrt(2*g/ ((d1/d2)^4 -1) *(P1*10^3 /(rho*g) -P2*10^3 /(rho*g)))
Q=%pi/4 *(d1/100)^2 *V1
//results
printf("Max discharge = %.4f m^3/s",Q)
//The answer given in textbook is wrong. Please use a calculator to verify
```

Scilab code Exa 5.7 Example 6

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
z1=1.2 //m
z2=4 //m
d=5 //cm
//calculations
Va=sqrt(2*g*(z2-z1))
Q=%pi/4 *(d/100)^2 *Va
Pc= - z2*rho*g
P=25*10^3 //Pa
Zab=(101325 - P)/rho/g
//results
printf("rate of discharge = %.4f m^3/s",Q)
printf("\n Pressure at C = %.2f kPa",Pc/1000)
printf("\n Max. permissible length = %.2f m",Zab)
```

Scilab code Exa 5.8 Example 7

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
Q=0.09 //m^3/s
d1=0.12 //m
d2=0.2 //m
P1=80 //kN/m^2
P2=120 //kN/m^2
//calculations
```

```
V1=Q/(%pi/4 *d1^2)
TE1 = P1*10^3 /(rho*g) + V1^2 /(2*g)
V2= d1^2 /d2^2 *V1
TE2= P2*10^3 /(rho*g) + V2^2 /(2*g)
//results
if TE1>TE2 then
    printf("Flow is from section 1 to section 2")
else
    printf("Flow is from section 2 to section 1")
end
```

Scilab code Exa 5.9 Example 8

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
Q=0.012 //m^3/s
z=10 //m
d=0.075 //m
//calculations
Vb=Q/(%pi/4 *d^2)
Hm=z+ Vb^2 /(2*g)
P=Hm*rho*g*Q
//results
printf("Power required = %.3f kW",P/1000)
```

Scilab code Exa 5.10 Example 9

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=860 //kg/m^3
```

```
P1=20 *10^3 //Pa
P2=50*10^3 //Pa
z=2.8 //m
d1=0.1 //m
//calculations
V1=sqrt(2*g*(P2/(rho*g) -z - P1/(rho*g)))
Q=%pi/4 *d1^2 *V1
//results
printf("rate of flow = %.4f m^3/s",Q)
```

Scilab code Exa 5.11 Example 10

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
Cv=0.92
P=210*10^3 //Pa
d=0.05 //m
ret=1.5 //m/s^2
//calculations
H=P/(g*rho)
Va=Cv*(2*g*H)
h=Cv^2 *H
h2= Cv^2 *2*g*H/(2*(g+ret))
//results
printf("The height to which the jet will rise is %.2
   f m",h)
printf("\n In case 2., height = %.2f m",h2)
```

Scilab code Exa 5.12 Example 11

```
clc
```

```
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
h=4 //m
d=0.03 //m
Qa=3.8/1000 //m^3/s
x=2.5 //m
y=0.41 //m
//calculations
Qth = %pi/4 *d^2 *sqrt(2*g*h)
Cd=Qa/Qth
Cv=sqrt(x^2 /(4*y*h))
Cc=Cd/Cv
//results
printf("Cd = %.2f",Cd)
printf("\n Cv = %.3f",Cv)
printf("\n Cc= %.2f",Cc)
```

Scilab code Exa 5.13 Example 12

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
rho2=13.6*10^3 //kg/m^3
d1=3.2 //m
d2=0.6 //m
//calculations
z1=d1*rho/rho2
head= d2+z1
V=sqrt(2*g*head)
//results
printf("Efflux velocity = %.2f m/s",V)
//The answer is a bit different due to rounding off
   error.
```

Scilab code Exa 5.15 Example 15

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
Cd=0.6
d=0.04 //m
h2=2.5 //m
//calculations
function y=fun(h)
    y=1/(Cd*%pi/4 *d^2 *sqrt(2*g)) *(4/sqrt(h) +
       sqrt(64-h^2))
endfunction
t=intg(0,h2,fun)
tmin=31.1
//results
printf("Time required = %.1f min",tmin)
```

Scilab code Exa 5.16 Example 16

```
clc
//Initialization of variables
g=981 //cm/s^2
Cd=0.6
Q=1200
d=3 //cm
l=30 //cm
b=30 //cm
dh=5 //cm
h1=9 //cm
```

```
//calculations
function y =fun1(h)
    y= l*b/(Q - Cd*%pi/4 *d^2 *sqrt(2*g*h))
endfunction
t=intg(h1,h1+dh,fun1)
t=126
//results
printf("Time required = %d sec",t)
```

Scilab code Exa 5.17 Example 17

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
pst=25.2*10^3 //Pa
h=2.5 //m
//calculations
v=sqrt(2/rho *(pst - g*rho*h))
//results
printf("velocity = %.2f m/s",v)
```

Scilab code Exa 5.18 Example 18

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
vel=800*10^3 /3600
sm=13.57
sl2=12.2
//calculations
sl=sl2/(g*rho)
```

```
y=vel^2 /(2*g*(sm/sl -1))
//results
printf("length of manometer = %d cm",y*100)
```

Scilab code Exa 5.19 Example 19

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
h=3.5 //m
//calculations
v=sqrt(2*g*h)
//results
printf("Speed necessary = %.1f m/s",v)
```

Scilab code Exa 5.20 Example 20

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
sm=13.6
s=1
Q=1 //m^3/s
d2=0.25 //m
d1=0.5 //m
nu=1e-6
//calculations
RN=Q*d1/(%pi/4 *d1^2 *nu)
Cv=0.98
yd= Q^2 *(1-d2^4 /d1^4)/(Cv^2 *%pi/4 *d2^2 *2*g)
y=yd/(sm/s -1)
```

```
//results
printf("Mercury manometer reading = %.2f cm",y*100)
```

Scilab code Exa 5.21 Example 21

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
sm=13.6
s=1
y=0.12 //m
Cv=0.984
d1=0.05 //m
d2=0.1 //m
nu=1e-6
//calculations
Q=Cv*%pi/4 *d1^2 *sqrt(2*g) /sqrt(1- (d1/d2)^4) * sqrt(y*(sm/s -1))
V1=Q/(%pi/4 *d2^2)
R=V1*d1/nu
//results
printf("Since, reynolds number is in required value, Flow rate = %.4f m^3/s",Q)
```

Scilab code Exa 5.22 Example 22

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
P1=150*10^3 //Pa
d0=3 //cm
```

```
d1=6 //cm
Cv=0.98
Cc=0.62
//calculations
P1g=P1/(g*rho)
Ar= (d0/d1)^4
A0=%pi/4 *(d0/100)^2
Q= Cv*Cc*A0 *sqrt(2*g) /sqrt(1- Cc^2 *Ar) *sqrt(P1g)
//results
printf("Discharge = %.2f lps",Q*10^3)
```

Scilab code Exa 5.23 Example 23

```
clc
clear
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
Cd=0.6
L=3 //m
H=0.4 //m
V0=[0 0.24 0.275]
//calculations
Q= Cd*2/3 *sqrt(2*g) *(L-0.2*H) *((H+ V0.^2 ./(2*g)
   ).^(3/2) - (V0.^2 ./ (2*g)).^(3/2))
//results
H=max(Q)
printf("Flow rate = %.3f m^3/s",H)
```

Scilab code Exa 5.24 Example 24

```
clc
//Initialization of variables
```

```
g=9.81 //m/s^2
rho=10^3 //kg/m^3
d=0.5 //m
vel=1 //m/s
depth=1.2 //m
Cd=0.62
//calculations
H=(d*3/(2*Cd))^(2/3)
hw=depth-H
//results
printf("height of weir plate = %.2f m",hw)
//The answer given in textbook is wrong please use a
    caclculator.
```

Scilab code Exa 5.25 Example 25

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
Q=0.1*100^2 /(24*3600) //m^3/s
Cd=0.61
theta=60 //degrees
Hd=Q/(Cd*8/15 *sqrt(2*g) *tand(theta/2))
H=Hd^(2/5)
//results
printf("apex of weir must be set %.1f cm below the
   free surface",H*100)
//The answer in the textbook is wrong. Please verify
    it
```

Scilab code Exa 5.26 Example 26

```
clc
//Initialization of variables
Q1=0.93
Q2=0.4
H1=0.7
H2=0.5
//calculations
n=log(Q1/Q2) /log(H1/H2)
//results
printf("Shape n = %.1f . hence shape of weir is
    triangular",n)
```

Scilab code Exa 5.27 Example 27

```
clc
//Initialization of variables
g=981 //cm/s^2
H=20 //cm
err=3/100
//calculations
dH=err/2.5 *H
v0=sqrt(2*g*dH)
//results
printf("Required velocity = %.2f cm/s",v0)
//The answer is a bit different due to rounding off
    error
```

Scilab code Exa 5.28 Example 28

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
```

```
Q=12000
f=30
t1=0.5
t2=1.2
//calculations
function y= fun2(h)
    y=Q/f *(1/h^(3/2))
endfunction
t=intg(t1,t2,fun2)
//results
printf("Time  = %d sec",t)
//The answer is a bit different due to rounding off
   error
```

Chapter 6

Dimensional Analysis and Similitude

Scilab code Exa 6.11 Example 11

```
clc
//Initialization of variables
dw=1000 //kg/m^3
muw=0.001 //N s /m^2
da=1.225 //kg/m^3
mua=18*10^-6 //N s /m^2
lr=1/10
//calculations
dr=da/dw
mur=mua/muw
vr=mur/dr
velocity= vr/lr
discharge =lr*vr
pressure = mur^2 /(dr*lr^2)
force = mur^2 /dr
//results
printf("Scale ratio for velocity = %d ",velocity)
printf("\nScale ratio for discharge = %.2f ",
   discharge)
```

```
printf("\nScale ratio for pressure = %.1f ",pressure
   )
printf("\nScale ratio for force = %.3f ",force)
```

Scilab code Exa 6.12 Example 12

```
clc
//Initialization of variables
dr=1000
mur=100
lr=1/10
dpm=60
//calculations
Vr=mur/dr/lr
dpr=dr*Vr^2
dpp=dpm/dpr
//results
printf("Pressure drop in prototype = %d N/m^2",dpp
   *10^3)
```

Scilab code Exa 6.14 Example 14

```
clc
//Initialization of variables
lr=1/25
Tp=6 //sec
dr=1/1.025
Fm=70 //N
//calculations
Tr=lr^(0.5)
Tm=Tr*Tp
Fr=dr*lr^3
Fp=Fm/Fr
```

```
//results
printf("Wave period = %.1f sec",Tm)
printf("Force = %.3f kN",Fp/1000)
```

Scilab code Exa 6.16 Example 16

```
clc
//Initialization of variables
lr=1/10
Vp=10 //knots
Fm=12 //N
//calculations
Vm=Vp*sqrt(lr)
Fp=Fm/lr^3
//results
printf("force = %.1f kN",Fp/1000)
```

Scilab code Exa 6.17 Example 17

```
clc
//Initialization of variables
lr=1/7200
//calculations
Tr=60/(12*3600)
yr=(lr/Tr)^2
//results
printf("vertical scale to be adopted is 1 in %d",1/
    yr)
```

Chapter 7

In compressible Flow through Conduits

Scilab code Exa 7.1 Example 1

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
h1=4 //m
muw=0.001 //Ns/m^2
l=1.5 //m
B=0.15/1000 //m
len=11.2 //m
//calculations
P1=g*rho*h1
V=P1*B^2 /(12*muw*l)
A=B*len
Q=A*V
Q=7112.4
tau= B/2 *(P1)/l
//results
printf("Average velocity through the crack = %.3f m/
   s",V)
```

```
printf("\n rate of leakage = %.1f l/hr",Q)
printf("\n Shear stress = %.3f N/m^2",tau)
```

Scilab code Exa 7.2 Example 2

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=1200 //kg/m^3
mu=0.005 //Ns/m^2
d=0.006 //m
Re=2000
V=0.15 //m/s
//calculations
Vc=Re*mu/(d*rho)
Vr=V/Vc
T0=8*mu*V/d
//results
printf("Shear stress = %d N/m^2",T0)
```

Scilab code Exa 7.3 Example 3

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
Q=0.45/(60*1000) //m^3/s
d=0.003 //m
depth=0.95 //m
alpha=2
len=1.25 //m
//calculations
A=%pi/4 *d^2
```

```
V=Q/A
nu= (depth - alpha*V^2 /(2*g))*g*d^2 /(32*V*len)
Re=V*d/nu
//results
if Re<2000 then
    printf("Flow is laminar")
else
    printf("Flow is not laminar")
end
```

Scilab code Exa 7.4 Example 4

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=787 //kg/m^3
Q=90*10^-3 //m^3/hr
d=0.015 //m
k=0.0045*10^-2 //m
nu=1.6e-6
l=5 //m
//calculations
V=Q/(60*%pi/4 *d^2)
Rn=V*d/nu
e=k/d
disp("From moody diagram, f=0.028")
f=0.028
hl=f*l/d *V^2 /(2*g)
Power=rho*g*Q/60 *hl
//result
printf("Head loss = %.2f m",hl)
printf("\n power required =%.3f kW",Power/1000)
```

Scilab code Exa 7.5 Example 5

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=870 //kg/m^3
Q=2*10^-3 //m^3/s
d=0.03 //m
mu=5*10^-4
l=50 //m
//calculations
V=Q/(%pi/4 *d^2)
RN=rho*V*d/mu
f=0.017
hl=f*l/d *V^2/(2*g)
Ploss=rho*g*hl
//results
printf("Loss of pressure = %.1f kN/m^2",Ploss/1000)
//The answers are a bit different due to rounding
   off error in textbook
```

Scilab code Exa 7.6 Example 6

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=813 //kg/m^3
Q=0.007 //m^3/hr
d=0.01//m
mu=0.002 //Ns/m^2
l=30 //m
//calculations
V=Q/(60*%pi/4*d^2)
RN=V*d*rho/mu
f=0.316/RN^(0.25)
```

```
h=(1+f*l/d)*V^2 /(2*g)
//result
printf("Height required = %.2f m",h)
```

Scilab code Exa 7.7 Example 7

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
hl=0.02
d=1.2 //m
l=1 //m
k=0.5 *10^-2 //m
//calculations
v2f=hl*(2*g*d)/l
e=k/d
f=0.028
V=sqrt(v2f/f)
Q=%pi/4 *d^2 *V
//results
printf("Rate of flow = %.2f m^3/s",Q)
```

Scilab code Exa 7.8 Example 8

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
e=0.03*10^-2 //m
l=3000 //m
Q=300*10^-3 //m^3/s
nu=10^-5 //m^2/s
```

```
hl=24 //m
//calculations
d5f= l*Q/(%pi/4) * Q/(%pi/4) /(hl*2*g)
f=0.022
d=(d5f*f)^(1/5)
//results
printf("Size of the required pipe = %d cm",d*100)
```

Scilab code Exa 7.9 Example 9

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
d=0.3 //m
per=25/100
Q=0.1 //m^3/s
k0=0.025*10^-2 //m
nu=0.000001
year=10
//calculations
V=Q/(%pi/4 *d^2)
RN=V*d/nu
e1=k0/d
f1=0.019
f2=(1+per)*f1
e2=0.002
k2=e2*d
rate = (k2-k0)*100/year
//results
printf("Rate of increase =%.4f cm/year",rate)
```

Scilab code Exa 7.10 Example 10

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
l=1 //m
b=0.3 //m
Q=4.2 //m^3/s
//calculations
A=l*b
R=A/(2*(l+b))
d5=1.62/24.15
d=d5^(1/5)
Pr=2*(l+b)/(%pi*d)
//results
printf("The rectangular cross section will cost %.2
    f times that of a circular cross section",Pr)
```

Scilab code Exa 7.11 Example 11

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
d1=2.5*10^-2 //m
d2=7.2*10^-2 //m
Q=100*10^-3 //m^3/hr
//calculations
V1=Q/(60*%pi/4*d1^2)
V2=(d1/d2)^2 *V1
dp= -(V2^2 -V1^2 + (V1-V2)^2)/(2*g)
Pdiff=dp*g*rho
//results
printf("pressure difference = %.2f kN/m^2",Pdiff
    /1000)
//The answers are a bit different due to rounding
```

```
    off error
```

Scilab code Exa 7.12 Example 12

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
d2=30/100 //cm
d1=60/100 //cm
Pu=105 //kN/m^2
Pd=75 //kN/m^2
Cc=0.65
//calculations
V22=(2*g/(1 - (d2/d1)^4 + (1/Cc -1)^2)) *(Pu-Pd)
    *10^3 /(rho*g)
V2=sqrt(V22)
Q=%pi/4 *V2 *d2^2
hl=(1/Cc -1)^2 *V2^2 /(2*g)
//results
printf("Flow rate = %.3f m^3/s",Q)
printf("\n Head loss = %.3f m",hl)
```

Scilab code Exa 7.13 Example 13

```
clc
//Initialization of variables
g=9.81 //m/s^2
rho=10^3 //kg/m^3
d=9 //m
dia=0.3 //m
//calculations
V302= 2*g*d/(0.5 + 20 + 2.53+101+0.66+41.47+2.07)
```

```
V30=sqrt(V302)
Q=%pi/4 *dia^2 *V30
//results
printf("Flow rate = %.3f m^3/s",Q)
```

Scilab code Exa 7.14 Example 14

```
clc
clear
//Initialization of variables
h=6 //m
rho=930 //kg/m^3
Q=3/60 //m^3/s
d=0.15 //m
L=20 //m
mu=0.006
g=9.81 //m/s^2
//calculations
V=Q/(%pi/4 *d^2)
RN=V*d*rho/mu
f=0.316/RN^0.25
hl=f*L/d *V^2 /(2*g)
Hp=h+hl
gam=rho*g
W=gam*Q
Power= W*Hp
//results
printf("Power required  = %.3f kW",Power/1000)
```

Scilab code Exa 7.15 Example 15

```
clc
//Initialization of variables
```

```
d=0.02 //m
d2=1.2 //m
f=0.01
L=250
ken=0.5
g=9.81
h1=8 //m
h2=4 //m
//calculations
V2=2*g/(1+ken+ f*L/d)
V=sqrt(V2)
Q=%pi/4 *d^2 *V
function t=time(h)
    t=-%pi/4 *d2^2 /Q /sqrt(h)
endfunction
ti=intg(h1,h2,time)
//results
printf("Time required = %d sec",ti)
```

Scilab code Exa 7.16 Example 16

```
clc
//Initialization of variables
d1=0.1 //m
d2=0.05 //m
l1=20 //m
l2=20 //m
f=0.02
//calculations
Kl=(f*l2/d2 *(d1/d2)^4 - f*l1/d1)
//results
printf("Loss coefficient = %d ",Kl)
```

Scilab code Exa 7.17 Example 17

```
clc
clear
//Initialization of variables
g=9.81
rati=1.265
//calculations
percent = (rati-1)*100
//results
printf("Increase in discharge = %.1f",percent)
```

Scilab code Exa 7.18 Example 18

```
clc
//Initialization of variables
Q=0.6 //m^3/s
l1=1200 //m
l2=800 //m
d1=0.3 //m
//calculations
V1=1.02 //m/s
d5= d1*l2*4^2 *Q^2 /(l1*%pi^2 *V1^2)
d=d5^(1/5)
//results
printf("diameter of the single pipe = %.2f m",d)
```

Scilab code Exa 7.19 Example 19

```
clc
//Initialization of variables
g=9.81
Q=0.18 //m^3/s
```

```
d3=0.3//m
f=0.032
L3=360 //m
z=25.5 //m
z2=30 //m
L2=450 //m
d2=0.45//m
L1=950 //m
d1=0.45 //m
zn=18 //m
rho=1000
//calculations
V3=Q/(%pi/4 *d3^2)
hl3=f*L3/d3 *(V3^2 /(2*g))
Z2=z+hl3
hl2=Z2-z2
V2= sqrt(2*g*d2*hl2/(f*L2))
Q2=%pi/4 *d2^2 *V2
V1=V2+ (d3/d2)^2 *V3
hl1=f*L1/d1*V1^2 /(2*g)
Hp= hl1+ Z2-zn
gam=rho*g
P=gam*Hp
//results
printf("Discharge into the reservoir = %.3f m^3/s",
    Q2)
printf("\n Pressure maintained by the pump = %.2f kN
    /m^2",P/1000)
```

Scilab code Exa 7.20 Example 20

```
clc
//Initialization of variables
h=[1 2 1.9 1.96]
z1=10 //m
```

```
z2=5 //m
z3=7.5 //m
f=0.04
l1=100 //m
l2=50 //m
l3=70 //m
d1=0.1 //m
d2=0.075 //m
d3=0.06 //m
g=9.81 //m/s^2
//calculations
Q1=sqrt(d1^5 *(%pi/4)^2 *2*g/(f*l1)) .*sqrt(z1-h)
Q2=sqrt(d2^5 *(%pi/4)^2 *2*g/(f*l2)) .*sqrt(h+z2)
Q3=sqrt(d3^5 *(%pi/4)^2 *2*g/(f*l3)) .*sqrt(h+z3)
len=length(h)
for i=1:len
    Q=Q2(i)+Q3(i)
    if (Q1(i) == Q) then
        break;
    end
end
printf("height h = %.2f m",h(i))
printf("\nDischarge in BC Q2 = %.2f lps",Q2(i)*1000)
printf("\nDischarge in BD Q3 = %.2f lps",Q3(i)*1000)
```

Scilab code Exa 7.21 Example 21

```
clc
//Initialization of variables
e=0.8
output=400 //kW
H=150 //m
rho=1000
g=9.81
f=0.028
```

```
l=1250 //m
//calculations
gam=rho*g
inpu=output/e
Q=inpu*10^3 /(2/3 *gam*H)
hl=1/3 *H
d5= f*l*Q^2 /(2*g* %pi/4 * %pi/4 *hl)
d=d5^(1/5)
//results
printf("Smallest diameter of pen stock = %d cm",d
    *100)
```

Scilab code Exa 7.22 Example 22

```
clc
//Initialization of variables
f=0.04
H=30 //m
l=200 //m
d=0.075 //m
g=9.81
rho=1000
gam=rho*g
//calculations
h=2/3 *H
vj=sqrt(2*g*h)
hl= 1/3 *H
V= sqrt(hl*d*2*g/(f*l))
dj= d*(sqrt(V/vj))
Power= 2/3 *gam*%pi/4 *d^2 *V*H
//results
printf("Size of nozzle = %.1f cm",dj*100)
printf("\n Max power = %.2f kW",Power/1000)
```

Chapter 8

Uniform Open Channel Flow

Scilab code Exa 8.1 Example 1

```
clc
//Initialization of variables
b=4 //m
y=1.2 //m
sf=0.001
n=0.012
gam=9.81*1000
//calculations
A=b*y
R=A/(b+ 2*y)
Q=1/n *A*R^(2/3) *sf^(1/2)
T=gam*R*sf
//results
printf("Discharge = %.3f m^3/s",Q)
printf("\n bed shear = %.2f N/m^2",T)
//The answer in textbook is wrong for discharge.
    Please use a calculator.
```

Scilab code Exa 8.2 Example 2

```
clc
//Initialization of variables
b=6 //m
y=2 //m
sf=0.005
slope = 2
gam=9.81*1000
Q=65 //m^3/s
//calculations
A=(b+ 2*y)*slope
P=b+ 2*y*sqrt(slope^2 +1)
R=A/P
V=Q/A
n=R^(2/3) *sf^(1/2) /V
//results
printf("Value of mannings coefficient = %.3f",n)
```

Scilab code Exa 8.3 Example 3

```
clc
//Initialization of variables
b=3 //m
y=1 //m
sf=0.005
n=0.028
gam=9.81*1000
Q=0.25 //m^3/s
slope=1.5
//calculations
A= 0.5 *b*y
P=2*sqrt(1 + (slope)^2)
R=A/P
yx= Q*n/(slope * R^(2/3) *sf^(1/2))
y= yx^(3/8)
//results
```

```
printf("depth = %.2f m",y)
```

Scilab code Exa 8.4 Example 4

```
clc
//Initialization of variables
sf=0.0064
n=0.015
Q=6 //m^3/s
gam=9.81*1000
//calculations
AR= n*Q/sqrt(sf)
disp("On trial and error, ")
y=0.385 //m
printf("normal depth = %.3f m",y)
```

Scilab code Exa 8.5 Example 5

```
clc
//Initialization of variables\
sf=0.00007
n=0.013
gam=9.81*1000
V=0.45 //m/s
Q=1.4 //m^3/s
//calculations
by=Q/V
x=poly(0,"x")
y=roots(x^2 -2.66*x +1.55)
b=by ./y
//results
printf("y = ")
disp( y )
```

```
printf("corresponding b=")
disp(b)
```

Scilab code Exa 8.6 Example 6

```
clc
//Initialization of variables
sf=0.0016
n=0.02
Q=0.84 //m^3/s
gam=9.81*1000
//calculations
y53= Q*n/sqrt(sf)
y=y53^(3/5)
//results
printf("depth of flow = %.2f m",y)
```

Scilab code Exa 8.7 Example 7

```
clc
//Initialization of variables
n=0.015
Q=1.3 //m^3/s
V=0.6 //m/s
gam=9.81*1000
//calculations
alpha=60 //degrees
A=0.5 *(1/2)^2 *(180-alpha)/180 *%pi -(1/4)^2 *tand(
    alpha)
A=0.206
P=0.5*(180-alpha)/180 *%pi
R=A/P
d2=V*n/(R^(2/3))
```

```
d8= Q*n*4*4^(2/3) /%pi
d=sqrt(d8/d2)
sf= (d2/d^(2/3))^2
//results
printf("Diameter = %.2f m",d)
printf("\n slope = %.5f ",sf)
//The answer given in textbook is wrong. please
   check
```

Scilab code Exa 8.8 Example 8

```
clc
//Initialization of variables
b=0.5 //m
y=0.35 //m
sf=0.001
nc=0.016
gam=9.81*1000
Q=0.15 //m^3/s
//calculations
A=b*y
P= b+ 2*y
R=A/P
ng=1/Q *A*R^(2/3) *sf^(1/2)
n= (b*nc^(3/2) + 2*y*ng^(3/2))^(2/3) /(P^(2/3))
Q2=1/n *A*R^(2/3) *sf^(1/2)
//results
printf("flow in case 2 = %.3f m^3/s",Q2)
```

Scilab code Exa 8.9 Example 9

```
clc
//Initialization of variables
```

```
b1=8 //m
b2=5 //m
y=5 //m
b5=15 //m
b3=3 //m
b4=3 //m
y2=2 //m
y3=3 //m
n1=0.025
n2=0.035
sf=0.0008
//calcuations
A= (b1+b2)*y
P= b1+ sqrt(b2^2 +y^2) + sqrt(b3^2 +b4^2)
R=A/P
Q1=1/n1 *A*R^(2/3) *sf^(1/2)
A2 = b5*y2 - 0.5*y2*y2 + 0.5*y3*y2
P2= b5 + sqrt(b4^2 + y3^2)
R2=A2/P2
Q2= 1/n2 *A2*R2^(2/3) *sf^(1/2)
Q=Q1+Q2
//results
printf("Total discharge = %.1f m^3/s",Q)
```

Scilab code Exa 8.10 Example 10

```
clc
//Initialization of variables
Q=12 //m^3/s
n=0.023
A=2.472
b=0.472
sf=1/8000
//calculations
y8= Q*n/A *2^(2/3) /sf^(1/2)
```

```
y=y8^(3/8)
b2= b*y
//results
printf("depth = %.3f m",y)
printf("\n width = %.2f m",b2)
```

Scilab code Exa 8.11 Example 11

```
clc
//Initialization of variables
Q=30
V=1
//calculations
A=Q/V
y = sqrt(A/(sqrt(2) + 0.5))
b= (A- 0.5*y^2)/y
//results
printf("width = %.2f m",b)
printf("\n depth = %.2f m",y)
```

Chapter 9

Potential Flow

Scilab code Exa 9.4 Example 4

```
clc
//Initialization of variables
k=1.5
r=40 //cm
theta=45 //degrees
//calculations
vr= -2*k*r*cosd(2*theta)
vt= 2*k*r*sind(2*theta)
//results
printf("velocity in radial direction = %d cm/s",vr)
printf("\n velcoity in angular direction = %d cm/s",
    vt)
```

Scilab code Exa 9.14 Example 14

```
clc
//Initialization of variables
T=4.5
```

```
a=0.6
u=5 //m/s
rho=1000 //kg/m^3
//calculations
sint=0.5*(1- T/(2*%pi*a*u))
theta= asind(sint)
dp= 0.5*rho*u^2 *(1 - (2 + T/(2*%pi*a*u))^2)
//results
printf("Angle = %.1f %.1f degrees",theta,180-theta)
printf("\n Min guage pressure = %.2f kN/m^2",dp
   /1000)
//The answer in textbook is wrong. please check
```

Scilab code Exa 9.15 Example 15

```
clc
//Initialization of variables
T=6*%pi
r=1/3
//calculations
vab=T/(4*%pi)
vba= T/(2*%pi)
w=vab/r
//results
printf("rate of rotation = %.1f rad/s",w)
printf("\nspeed of A by B = %.1f m/s",vab)
printf("\nspeed of B by A = %.1f m/s",vba)
```

Chapter 10

The Boundary Layer

Scilab code Exa 10.1 `Example 1`

```
clc
//Initialization of variables
v=30 //m/s
nu=1.5e-5 //m^2/s
//calculations
Re=5*10^5
xc= Re*nu/v
//results
printf("Transistion region = %.2f m",xc)
```

Scilab code Exa 10.2 `Example 2`

```
clc
//Initialization of variables
u=2 //m/s
x=0.15 //m
nu=1.5e-5 //m^2/s
B=0.5 //m
```

```
rho=1.22 //kg/m^3
//calcualtions
Rx=u*x/nu
delta= 4.91*x/sqrt(Rx)
deltas=1.729*x/sqrt(Rx)
Cf=1.328/sqrt(Rx)
Ff=Cf*0.5*rho*u^2 *2*B*x
//results
printf("Boundary layer thickness = %.2f cm",delta*100)
printf("\n Displacement thickness = %.2f cm",deltas*100)
printf("\n Average drag coeffcient = %.4f",Cf)
printf("\n Drag force = %.4f N",Ff)
```

Scilab code Exa 10.5 Example 5

```
clc
//Initialization of variables
U=172*1000/3600 //m/s
w=3 //m
h=3 //m
L=100 //m
nu=1.5e-5 //m^2/s
rho=1.22 //kg/m^3
//calculations
Rl=U*L/nu
Cf=0.074 /(Rl^(1/5))
Ff=Cf*0.5*rho*U^2 *w*h*L
power= Ff*U
//results
printf("power required = %.1f kW",power/1000)
//The answer is a bit different due to rounding off error
```

Scilab code Exa 10.6 Example 6

```
clc
//Initialization of variables
U=4000 //m/s
L=8 //m
nu=3600e-6 //m^2/s
rho=1000 //kg/m^3
b=5 //m
//calculations
Rl=U*L/nu
Cf= 0.074/Rl^(1/5) -1700/Rl
Ff=Cf*0.5*rho*(U/3600)^2 *L*b
//results
printf("Skin friction drag = %.2f N",Ff)
```

Chapter 11

Forces on Immersed Bodies

Scilab code Exa 11.1 `Example 1`

```
clc
//Initialization of variables
d=1.2 //m
w=1 //m
U=60*1000/3600 //m/s
nu=1.5e-5 //m^2/s
Cd=0.4
rho=1.22 //kg/m^3
//calculations
Rn=U*d/nu
A=d*w
Fd= Cd*0.5*rho*U^2 *A
M= 0.5*Fd
//results
printf("Bending moment = %.2f h^2 N m",M)
```

Scilab code Exa 11.2 `Example 2`

```
clc
//Initialization of variables
d=0.006 //m
U=0.01 //m/s
gaml=8000 //N/m^3
gams=7.9*10^3 *9.81
mu=13.9
//calculations
mu= d^2 /18 *(gams - gaml)/U
RN= U*d*(gaml/9.81) /mu
//results
printf("Viscosity of oil = %.1f Ns /m^2",mu)
```

Scilab code Exa 11.3 Example 3

```

clc
//Initialization of variables
s=2.7
gamw=9810 //N/m^3
mu=0.001 //Ns/m^2
d=0.15*10^-3 //m
rho=1000 //kg/m^3
//calculations
gams=s*gamw
U= d^2 *(gams-gamw)/(18*mu)
RN= U*d*rho/mu
Cd = (1+ 3/16 *RN)^0.5 *(24/RN)
U22 = 4/3 *d*(gams-gamw) /(Cd*rho)
U2=sqrt(U22)
//results
printf("Settling velocity of sand in case 1  = %.2f
   m/s",U)
printf("\n Settling velocity of sand in case 2 = %.4
   f m/s",U2)
```

```
//The answer is a bit different due to rounding off
   error.
```

Scilab code Exa 11.4 Example 4

```
clc
//Initialization of variables
A=2 //m^2
U=100*1000/3600 //m/s
Cd=0.32
rho=1.24
//calculations
Fd= Cd*0.5*rho*U^2 *A
P= Fd*U
//results
printf("Power required = %.1f kW",P/1000)
```

Scilab code Exa 11.5 Example 5

```
clc
//Initialization of variables
ratio=0.15
//calculations
VU= (1/(1-ratio))^(1/3)
percent= (VU-1)*100
//results
printf("percent increase in speed = %.1f ",percent)
```

Scilab code Exa 11.6 Example 6

```
clc
//Initialization of variables
U=50*1000/3600 //m/s
cd1=0.34
cd2=1.33
//calculations
disp("On solving for both convex and concave
    surfaces,")
w=18.26 //m/s
N=w/(2*%pi) *60
//results
printf("rotational speed = %.1f rpm",N)
```