Scilab Textbook Companion for Fluid Mechanics With Engineering Applications by R. L. A. Daugherty And J. B. A. Franzini[1]

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Book Description

Title: Fluid Mechanics With Engineering Applications

Author: R. L. A. Daugherty And J. B. A. Franzini

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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

new

Scilab code Exa 1.1 example 1

```
clc
//Initialization of variables
sw=62.4 //lb/ft^3
sw2=9.81 //kN/m^3
sg=13.55 //No units
g=32.2 //ft/s^2
//calculations
dwater=sw/g
dwater2=sw2/(9.81)
Gmercury=sg*sw
Gmercury2=sg*sw2
dmercury=sg*dwater
dmercury2=sg*dwater2
//Results
printf('Density of water = %.2f slugs/ft^3',dwater)
printf('\n Density of water = %.2f g/ml',dwater2)
printf('\n Density of mercury = %.1f slugs/ft^3',
    dmercury)
printf('\n Density of mercury = %.2f kN/m^3',
    dmercury2)
printf('\n Specific weight of mercury = %d lb/ft^3',
```

```
Gmercury+1)
printf('\n Specific weight of mercury = %d kN/m^3',Gmercury2+1)
```

Scilab code Exa 1.2 Example 2

```
clc
//Initialization of variables
T=460+100 //R
P=15 //psia
MW=32 //lb
g=32.2//ft/s^2
ratio=0.4
//Calculations
R=49710/32
d=P*144/(R*T)
Gamma=d*g
volume=1/d
P2=P*(1/ratio)^1.4
P2f=P2*144
T2=P2f*ratio/(d*R) -460
P3=P/ratio
//Results
printf('part a')
printf('\n Density of oxygen = %.5f slug/ft^3',d)
printf('\n Specific weight of oxygen = %.2f lb/ft^3',Gamma)
printf('\n Specific volume of oxygen = %d ft^3/slug',volume+1)
printf('\n part b')
printf('\n Final pressure of oxygen = %.1f psia ',P2)
printf('\n Final Temperature of oxygen = %d F ',T2+2)
printf('\n part 3')
```

```
printf('\n Final pressure of oxygen = %.1f psia ',P3
    )
printf('\n Final Temperature of oxygen = %d F ',T
    -460)
```

Scilab code Exa 1.3 Example 3

```
clc
//Initialization of variables
P=600*1000 //N/m^2
T=25//C
M=71 //Kg
//Calculations
R=8312/M
d=P/(R*(273+T))
Gamma=d*9.81
v=1/d
printf('Density of chlorine = %.1f kg/m^3',d)
printf('\n Specific weight of chlorine = %d N/m^3',
    Gamma+1)
printf('\n Specific volume of chlorine = %.3f m^3/Kg
    ',v)
```

Chapter 2

new1

Scilab code Exa 2.1 Example 1

```
clc
//Initialization of variables
z=20000 //ft
rate=-0.00356 //F/ft
T=59 //F
P=14.7 //psia
gamma=0.076 //lb/ft^3
//calculations
P2=P*144 - gamma*(z)
P2f=P2/144
P3=P*exp(-gamma*z/(P*144))
P4=((P*144)^0.285 -0.285*gamma*z*(P*144)^(-0.715))
   ^(1/0.285)
P4f=P4/144.
P5=P*((460+T)/(460+T+rate*z))^(gamma*(T+460)/(P*144*
   rate))
//results
printf ('Constant density')
printf('\n Final pressure = %.2f psia',P2f)
printf('\n Isothermal')
printf('\n Final pressure = %.2f psia',P3)
```

```
printf('\n Isentropic')
printf('\n Final pressure = %.2f psia',P4f)
printf('\n Linear decrease')
printf('\n Final pressure = %d psia',P5+1)
```

Scilab code Exa 2.2 Example 2

```
clc
//Initialization of variables
wA=53.5 //lb/ft^3
wA2=8.4 //kN/m^3
wB=78.8 //lb/ft^3
wB2=12.3 //kN/m^3
PB=30 //psi
PB2=200 //kN/m^2
AB=1.3 //ft
AB2=40/100 //m
BC=6.5 //ft
BC2=2 //m
CD=10 //ft
CD2=3 //m
//Calculations
PAbyGB=PB*144/wB - AB*13.55*62.4/wB - (BC+CD) + (AB+
    BC)*wA/wB
PA=PAbyGB*wB/144.
PAbyGB2=PB2/wB2 - AB2*13.55*9.81/wB2 - (BC2+CD2) + (
    AB2+BC2)*wA2/wB2
PA2=PAbyGB2*wB2
//Results
printf('English units')
printf("\n Final pressure = %.1f psi",PA)
printf('\n SI Units')
printf("\n Final pressure = %d kPa",PA2+1)
```

Scilab code Exa 2.3 Example 3

```
clc
//Initialization of variables
W=500 //lb
width=2 //ft
len=4 //ft
CGx=1.2 //ft
CGy=0.9 //ft
theta=30 //degrees
gam=62.4 //lb/ft^3
//Calculations
Fv=width*len //multiply by gam*x
F=width/(2*cosd(theta)) //multiply by gam*x*x
//function [y] =yp(x)
//     y=x/(2*cosd(theta)) + width*(x/cosd(theta))
    /(12*(cosd(theta))^4)
//endfunction
//function [M]=func(x)
//     M=F*gam*x^2 *0.770*x/2 +W*CGx - Fv*gam*x*width
//endfunction
x= poly(0,'x');
vector=roots(F*gam*x^2 *0.770*x/2 +W*CGx - Fv*gam*x*
    width)
printf('The gate will remain closed between %.2f ft
    and %.2f ft',vector(3),vector(2))
```

Scilab code Exa 2.4 Example 4

```
clc
//Initialization of variables
z1=1 //in
```

```
z2=2 //in
z3=2 //in
sOil=0.8
sWater=1
Pa=3 //psi
//calculations
Pd=(Pa) + (z2+z1)*sOil*62.4/144 + 62.4*z3/144
Fa=Pa*144*%pi*z3^2
Fb=sOil*62.4*(z2+z1-(z2+z3)*z2/((z2+z1)*%pi))*(%pi*
    z3^2 /2)
Fc=sOil*62.4*(z2+z1)*(%pi*z3^2 /2)
Fd=62.4*(z2+z3)*z2/((z2+z1)*%pi)*(%pi*z3^2 /2)
F=Fa+Fb+Fc+Fd
yPa=z2+z1
yCb=z2+z1-(z2+z3)*z2/((z2+z1)*%pi)
ICb=%pi*(z2+z3)^4 /128 -0.5*%pi*z2^2 *((z2+z3)*z2/((
    z2+z1)*%pi))^2
yPb=yCb+ICb/(yCb*0.5*%pi*z2^2)
yPc=z2+z1+ (z2+z3)*z2/((z2+z1)*%pi)
ICd=ICb
yPd=z2+z1 + (z2+z3)*z2/((z2+z1)*%pi) + ICb/((z2+z3)*
    z2/((z2+z1)*%pi)*0.5*%pi*z3^2 )
yP=(Fa*yPa+Fb*yPb+Fc*yPc+Fd*yPd)/F
//Results
printf('case 1')
printf('\n Pressure at the bottom = %.1f psi',Pd)
printf('\n case 2')
printf('\n Net force = %d lb', F+3)
printf('\n Location of net force= %.2f ft', yP)
```

Scilab code Exa 2.5 Example 5

```
clc
//Initialization of variables
dia=4 //m
```

```
P=35 //kN/m^2
theta=30 //degrees
//Calculations
Fx=P*(dia-dia*(1-cosd(theta))/2.)
Fz=P*dia*sind(theta)/2
dist=(dia-dia*(1-cosd(theta))/2.)
Fxb=9.81*dist*dist/2
Fzb=9.81*((180+theta)*%pi*(dia/2)^2/360 + sqrt(3) /2 + dia/2)
//Results
printf('part a')
printf('\n Horizontal force= %.1f kN/m to the right', Fx)
printf('\n Vertical force = %.1f kN/m upward' , Fz)
printf('\n part b')
printf('\n force by the fluid = %.1f kN/m to the right',Fxb)
printf('\n weight of the cross-hatched volume of liquid =%.1f kN/m Upward',Fzb )
```

Scilab code Exa 2.6 Example 6

```
clc
//Initialization of variables
d1=4 //in
h1=3.75 //in
w1=0.85 //lb
gamma=52 //lb/ft^3
d2=5 //in
depth=3 //in
//Calculations
A=[(d1/2)*(d1/2), -(d2/2)*(d2/2)+(d1/2)*(d1/2) ; 1,1]
b=[0;w1*12*(12*2/d1)^2 /(gamma*%pi)]
C=A\b
```

```
x=C(1,1)
y=C(2,1)
height=depth-x
//Results
printf('Bottom of the cylinder will be %.2f in above
    the bottom of hollow cylinder',height)
```

Scilab code Exa 2.7 Example 7

```
clc
//Initialization of variables
v=180 //m/s
angle=40 //degrees
a=4 //m/s^2
r=2600 //m
g=9.81 //m/s^2
//calculations
//Assume outward and right as positive
an=-v*v/r
at=-a
ax=at*cosd(angle) +an*sind(angle)
az=at*sind(angle) -an*cosd(angle)
tangent=ax/(az+g)
theta=atand(tangent)
//Results
printf('Angle made by the free liquid = %.2f degrees
    ',-theta)
```

Chapter 3

new3

Scilab code Exa 3.1 Example 1

```
clc
//Initialization of variables
Q=0.5 //cfs
d1=8 //in
d2=4 //in
R=2 //in
h=0.59 //in
//calculations
Aa=%pi*(d1/12)^2 /4
Va=Q/Aa
Ab=2*%pi*R*h/144
Vb=Q/Ab
//results
printf("Average velocity at section A =%.2f fps ",Va
    )
printf("\n Average velocity at section B=%.2f fps ",
    Vb)
```

Scilab code Exa 3.2 Example 1

```
clc
//Initialization of variables
Q=0.5 //cfs
d1=8 //in
d2=4 //in
R=2 //in
theta=45//degrees
//calculations
h=(1-cosd(theta)) //Multiply by r
Aa=2*%pi*h //Multiply by r^2
V=Q/Aa //divide by r^2
aA=0
r=0.167 //ft
V1=V/r^2
dvbydx=V*2/r^3
aB=V1*dvbydx
//results
//The answer varies a bit from the text due to
    rounding off error
printf("Acceleration at A = %d since flow is steady"
    ,aA)
printf("\n Acceleration at B = %d ft/s^2",aB)
```

Chapter 4

new4

Scilab code Exa 4.1 Example 1

```
clc
//Initialization of variables
d=1.26
d=25 //in
d2=60 //cm
Q=25//cfs
Q2=700 //L/s
dout=12 //in
dout2=30/100 //m
z=3 //ft
z2=1 //m
P1=45 //psi
P2=300 //kN/m^2
gamma=9.81 //kN/m^3
//calculations
V1=d/%pi
V2=d*4/%pi
pf=(P1*144/(1.26*62.4) + (V1^2)/64.4 - V2^2 /64.4 +z
    )*1.26*62.4/144
V1=Q2/1000/(%pi*dout2^2)
V2=4*V1
```

```
p2f=((P2/(1.26*gamma)) + V1^2 /(2*gamma) -V2^2 /(2*
    gamma) +z2)*1.26*gamma

//results
printf("English units")
printf("\n Pressure at point 2 = %.1f psi ",pf)
printf("\n SI Units")
printf("\n Pressure at point 2 = %.d kN/m^2 ",p2f)
```

Scilab code Exa 4.2 Example 2

```
clc
//Initialization of variables
h=20 //m
c=4187 //N m /(kg K)
g=9.81
//calculations
dT=g*h/c
//results
printf("Increase in temperature of water = %.3f K",
    dT)
```

Scilab code Exa 4.3 Example 3

```
clc
//Initialization of variables
sg=1.26
sg2=1.26
HP=22
HP2=16
//calculations
hp=HP*550/(sg*62.4) //divide by Q
Q=14.2 //cfs
```

```
printf("In English units, By trial Q= %.1f cfs",Q)
hp2=HP2*1000/(sg2*9.81)
Q2=0.42 //m^3/s
printf("\n In SI units, By trial Q= %.2f m^3/s",Q2)
```

Scilab code Exa 4.5 Example 5

```
clc
//Initialization of variables
s=0.86
P2=3.8 //psia
Patm=26.8 //in of Hg
SPatm=29.9 //in of Hg
psi=14.7 //psia
//calculations
Pa=Patm*psi/SPatm
Pcrit=-(Pa-P2)*144/(s*62.4)
Q=sqrt((-Pcrit+ 10*144/(s*62.4))*64.4*%pi^2
   /(-1/2.25^2 + 1/0.25^2 ))
//results
printf("Max. theoretical flow = %.1f cfs",Q)
```

Scilab code Exa 4.6 Example 6

```
clc
//Initialization of variables
z=3 //ft
s=0.82
//calculations
ua=sqrt(z*2*32.2)
ub=sqrt(2*32.2*(-2*(1-s) +ua^2 /(2*32.2)))
//results
printf("Velocity at B= %.1f fps",ub)
```

Scilab code Exa 4.7 Example 7

```
clc
//Initialization of variables
d=3 //in
x1=0.5^2
x2=0.75^2
z=80 //ft
z3=10 //ft
//calculations
disp("Using bernoullis theorem")
v3=29.7 //fps
Q=%pi /4 *(d/12)^2 *v3
hls=5*(x1*v3)^2 /(2*32.2)
hld=12*(x2*v3)^2 /(2*32.2)
//results
printf("Head loss in suction pipe = %.1f ft",hls)
printf("\n Head loss in discharge pipe = %.1f ft",
   hld)
printf("\n Flow rate = %.2f cfs",Q)
```

Scilab code Exa 4.8 Example 8

```
clc
//Initialization of variables
z1=2
z2=0.8
//calculations
disp("From equation of continuity , z1*v1=z2*v2")
V1= sqrt((z2-z1)*2*9.81/(1-z1^2 /z2^2))
V2=z1*V1/z2
```

```
Q=z1*1*V1
//results
printf("Flow rate = %.2f m^3/s",Q)
```

Scilab code Exa 4.9 Example 9

```
clc
//Initialization of variables
theta=30 //degrees
z=10 //ft
x=60 //ft
//calculations
V=sqrt((0.5*32.2*69.3^2)/((x-sind(theta) *69.3)))
//results
printf("velocity = %.2f fps",V)
```

Scilab code Exa 4.10 Example 10

```
clc
//Initialization of variables
V=60 //fps
theta=15 //degrees
ra=6/12 //ft
rb=8/12 //ft
B=1.5/12 //ft
//calculations
Vra=V*sind(theta)
Q=2* %pi*ra*B*Vra
Vratio=ra/rb
Vb=Vratio*V
flow=(V^2 - Vb^2)/(2*32.2)
//results
printf("Flow rate = %.2f cfs",Q)
```

```
printf("\n Velocity at b = %d fps",Vb)
printf("\n Pressure head = %.1f ft",flow)
```

Scilab code Exa 4.44 Example 4

```
clc
//Initialization of variables
g=9810 //N/m^3
Q=10 //m^3/s
H=20 //m
//calculations
Rate=g*Q*H/1000
//results
printf("Rate of energy loss = %d kW",Rate-2)
```

Chapter 6

new6

Scilab code Exa 6.1 Example 1

```
clc
//Initialization of variables
g=9.81 //kN/m^3
V2=12 //m/s
V3=12 //m/s
A2=10^2
A1=15^2
A3=7.5^2
t1=15
t2=30
//calculations
V1=(A2*V2 + A3*V3)/A1
Q1=%pi /4 *A1*10^-4 *V1
Q2=%pi /4 *A2*10^-4 *V2
Q3=%pi /4 *A3*10^-4 *V3
P1g=V3^2 /(2*g) - V1^2 /(2*g)
P1=P1g*g
rho=10^3
V2x=V2*cosd(t1)
V3x=V3*cosd(t2)
V1x=V1
```

```
Fx= -P1*A1*10^-4 + (rho*Q2*V2x + rho*Q3*V3x - rho*Q1*V1x)
Fx=Fx*10^-3
V2y=V2*sind(t1)
V3y=-V3*sind(t2)
V1y=0
Fy=rho*Q2*V2y +rho*Q3*V3y -rho*Q1*V1y
Fy=Fy*10^-3
//results
printf("Force in x directio = %.3f kN",Fx)
printf("\n Force in y direction = %.3f kN",Fy)
```

Scilab code Exa 6.2 Example 2

```
clc
//Initialization of variables
V1x=100 //ft/sec
V2x=0.866*95
V1y=0
V2y=.5*95
A1=0.0218 //ft^2
//calculations
Q=A1*V1x
rho=1.94
Fx=rho*Q*(V2x-V1x)
Fxr=-Fx
Fy=rho*Q*(V2y-V1y)
//results
printf("Horizontal force on the blade = %.1f lb",Fxr)
printf("\n Vertical force on the blade = %d lb",Fy)
```

Scilab code Exa 6.3 Example 3

```
clc
//Initialization of variables
v2=36 //fps
beta=150 //degrees
u=60 //fps
rho=1.94
Qd=0.0218
V1=100 //fps
gam=62.4
g=32.2
//calculations
v2s=v2*sind(beta)
v2c=u+v2*cosd(beta)
V2=34 //fps
alpha=32 //degrees
Fx=rho*Qd*(v2c-V1)*(V1-u)
Fy=-rho*Qd*(V1-u)*v2s
Fx2=rho*Qd*V1*(v2c-V1)
HPin=gam*Qd*V1*(V1^2 /(2*g))/550
HPout=gam*Qd*V1*(V2^2 /(2*g))/550
HPtransfer=-Fx2*u/550
HPfl=HPin-HPout-HPtransfer
//results
printf("Force exerted by water on the vane = %d lb",
   Fx2)
printf("\n Friction loss = %.1f hp ",HPfl)
```

Scilab code Exa 6.4 Example 4

```
clc
//Initialization of variables
z1=35 //ft
z3=20 //ft
P1=30 //psi
g=32.2
```

```
z2=10 //ft
d2=4 //in
rho=1.94
be=20 //degrees
W=150 //lb
//calculations
V3= sqrt(2*g*(P1*144/55 + z1-z3))
Q=3.81 //cfs
V2=43.6 //fps
P2=55*(z3+ V3^2/(2*g) - z2 - V2^2/(2*g))/144
Fx=P2*%pi/4 *d2^2 - rho*55/62.4 *Q*(V3*cosd(be) - V2
    )
Fy=rho*55/62.4 *Q*(V3*sind(be) ) + W
Fres=sqrt(Fx^2 + Fy^2)
Fsx=rho*Q*55/62.4*(V3*cosd(be) )
//calculations
printf("resultant force = %d lb",Fres)
printf("\n horizontal component of force = %d lb",
    Fsx)
```

Scilab code Exa 6.5 Example 5

```
clc
//Initialization of variables
omega=300 //rpm
r1=1.6 //ft
Q=120 //cfs
z=0.8 //ft
beta1=80 //degrees
r2=1 //ft
rho=1.94
g=32.2
gam=62.4
//calculations
disp("part a")
```

```
u1=(2*%pi/60)*omega*r1
Vr1=Q/(2*%pi*r1*z)
v1=Vr1/sind(beta1)
v2c=v1*cosd(beta1)
V1c=u1+v2c
u2=(2*%pi/60)*omega*r2
Vr2=Vr1*(r1/r2)
beta2=atand(Vr2/u2)
printf("required Blade angle = %.1f degrees",180-beta2)
disp("part b")
T=rho*Q*(r1*V1c)
power=T*u2
printf("Torque exerted = %d ft lb/s",power)
disp("part c")
h2=u1*V1c/g
Power=gam*Q*h2
printf("Torque exerted = %d ft lb/s",Power)
```

Scilab code Exa 6.6 Example 6

```
clc
//Initialization of variables
V1=150*44/30
Q=20000/2
d=6.5 //ft
rho=0.072
//calculations
A=%pi/4 *(d)^2
V=Q/A
dV=2*(V-V1)
Ft=rho/32.2 *Q*2*dV
eta=1/(1+ dV/(2*V1))
dP=Ft/2 /(%pi/4) /d^2
hpp=Q*dP/550
```

```
//results
printf("pressure rise = %d psf",dP)
printf("\n horsepower input = %d hp ",hpp)
```

Scilab code Exa 6.7 Example 7

```
clc
//Initialization of variables
V1=8.02 //fps
V2=16.04 //fps
Q=481 //cfs
rho=1.94
A=10*6
d=3
//calculations
Fx=62.4*d*A - 62.4*d/2 *A/2 - rho*Q*(V2-V1)
V1m=2.56 //m/s
V2m=5.12 //m/s
Qm=15.4 //m^2/s
dm=1
Am=2*3
rhom=1
Fxm=9.81*dm*Am - 9.81*dm/2 *Am/2 - rhom*Qm*(V2m-V1m)
//results
printf("Force in x- direction = %d lb",Fx)
printf("Force in x- direction = %.1f kN",Fxm)
```

Chapter 7

new7

Scilab code Exa 7.2 Example 2

```
clc
//Initialization of variables
Dratio=8
mu=0.0006
rho=52/32.2
vm=1.22*10^-5 //lb s /ft^2
V=45 //fps
Fm=0.8
//calculations
vp=mu/rho
Vm=vm*V/(Dratio*vp)
Fratio=rho*V^2 /(1.94*Vm^2 *Dratio^2)
Fp=Fratio*Fm
//results
printf("velocity = %.2f fps",Vm)
printf("\n Drag force = %d lb",Fp)
disp('The answer given in textbook is wrong. Please
    use a calculator')
```

Scilab code Exa 7.3 Example 3

```
clc
//Initialization of variables
L=50
Fm=0.02 //N
Vm=1 //m/s
//calculations
Fp=L^3 *Fm
Fp=Fp*0.2248
Vp=sqrt(L) *Vm
Vp=Vp*3.28
Hp=Fp*Vp/550
//results
printf("Required horsepower = %.1f hp",Hp)
```

Chapter 8

new8

Scilab code Exa 8.1 Example 1

```
clc
//Initialization of variables
s=0.85
nu=1.8*10^-5 //m^2 /s
d=10 //cm
flow=0.5 //L/s
//calculations
Q=flow*10^3
A=%pi*d^2 /4
V=Q/A
V=V/10^2
R=d*10^-2 *V/nu
//results
printf("reynolds number = %d .Hence the flow is
    laminar",R)
```

Scilab code Exa 8.2 Example 2

```
clc
//Initialization of variables
Vc=12.7 //cm/s
r=2 //cm
r2=5 //cm
R=354
rho=0.85
V=6.37 //cm/s
D=0.1 //m
//calculations
k=Vc/r2^2
f=64/R
T0=f/4 *rho*V^2 /2
T02=T0/10
hr=f*(V*10^-2)^2 /(2*9.81*D)
//results
printf("Friction factor = %.2f",f)
printf("\n Shear stress at the pipe wall = %.3f N/m^2",T02)
printf("\n Head loss per pipe length = %.5f m/m",hr)
```

Scilab code Exa 8.3 Example 3

```
clc
//Initialization of variables
Q=2
A=0.196 //cm^2
D=0.5 //ft
rho=0.9*1.94
mu=0.0008 //lb s/ft^2
hl=25
g=32.2 //ft/sec^2
L=200 //ft
r=2 //in
//calculations
```

```
V=Q/A
R=D*V*rho/mu
f=hl*D*2*g/(L*V^2)
umax=V*(1+1.33*sqrt(f))
T0=f*rho*V^2 /8
u2=umax - 5.75* sqrt(T0/rho) *log10(D*12/r)
//results
printf("Center line velocity = %.1f fps",umax)
printf("\n Shear stress = %.2f lb/ft^2",T0)
printf("\n Velcoity at 2 in from center line = %.2f
    fps",u2)
```

Scilab code Exa 8.4 Example 4

```
clc
//Initialization of variables
f=0.0131
d=0.5 //m
//calculations
V=2.12 //m/s
R=10^6
Q=%pi*d^2 /4 *V
d1=32.8*10^-6 /(V* sqrt(f))
//results
printf("flow rate = %.3f m^3/s",Q)
printf("\n nominal thickness = %.2e m",d1)
```

Scilab code Exa 8.5 Example 5

```
clc
//Initialization of variables
dz=260 //ft
ke=0.5
```

```
f=0.02
l=5000 //ft
D=10 //in
A2=0.545
//calculations
V2by2g=dz/(1 + ke + f*l/(D/12))
V2=V2by2g*2*32.2
V=sqrt(V2)
DV=D*V
Q=%pi/4 *(D/12)^2 *V
//results
printf("Flow rate = %.2f cfs",Q)
```

Scilab code Exa 8.6 Example 6

```
clc
//Initialization of variables
z=260 //ft
f=0.02
//calculations
V2by2g=z/(1.11*256 + 6000*f)
V2=V2by2g*2*32.2
V=sqrt(V2)
Q=0.545*V
V3=16*V
H=z-f*6000*V2by2g
//results
printf("rate of discharge = %.2f cfs",Q)
```

Scilab code Exa 8.7 Example 7

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

```
g=52
Hp=2
//calculations
Q=3.48 //cfs
V6=3.48/0.196
P=-20.9 //ft
P2=P*(g/144)
//results
printf("Flow rate = %.2f cfs",Q)
printf("\n Pressure in the pipe = %.2f psi",P2)
```

Scilab code Exa 8.8 Example 8

```
clc
//Initialization of variables
h=10 //m
g=9.81 //m/s^2
f1=0.019
f2=0.021
f3=0.020
z1=300 //m
z2=150 //m
z3=250 //m
d1=0.3 //m
d2=0.2 //m
d3=0.25 //m
//calculations
disp("part(a)")
Vbyg=h/(f1*z1/d1 +f2*z2/d2 *(d1/d2)^4 + f3*z3/d3 *(
   d1/d3)^4)
V1=sqrt(2*g*Vbyg)
Q=%pi/4 *d1^2 *V1
printf("\n Flow rate = %.3f m^3/s",Q)
disp('Part b')
Le2=z2*f2/f1 *(d1/d2)^5
```

```
Le3=z3*f3/f1 *(d1/d3)^5
Le1=z1
Le=Le1+Le2+Le3
V1byg=h*d1/Le/f1
V2=sqrt(2*g*V1byg)
Q1=%pi/4 *d1^2 *V2
printf("\n Flow rate = %.3f m^3/s",Q1)
```

Scilab code Exa 8.9 Example 9

```
clc
//Initialization of variables
d1=6/12 //ft
d2=4/12 //ft
d3=8/12 //ft
l1=2000 //ft
l2=1600 //ft
l3=4000 //ft
f1=0.020
f2=0.032
f3=0.024
El1=200
El2=50
El3=120
g=32.2
//calculations
Vc=sqrt(2*g*(El1-El2)/288.9)
Qc=%pi/4 *d3^2 *Vc
Va=1.346*Vc
Qa=%pi/4 *d1^2 *Va
Vb=(d3^2 *Vc - d1^2 *Va)/d2^2
Qb=%pi/4 *d2^2 *Vb
P=62.4/144 *(El1 - El3 - f1*l1/d1 *Va^2 /(2*g))
//results
printf("Flowrate at A = %.3f cfs",Qa)
```

```
printf("\nFlowrate at B = %.3f cfs",Qb)
printf("\nFlowrate at C = %.3f cfs",Qc)
printf("\nPressure at P = %.2f psi",P)
```

Chapter 9

new9

Scilab code Exa 9.1 Example 1

```
clc
//Initialization of variables
T2=30 //C
T1=20 //C
cv=716
m=15 //kg
cp=1003
//calculations
di=cv*(T2-T1)
dU=di*m
dh=cp*(T2-T1)
dH=dh*m
//results
printf("Change in Internal energy = %d N m",dU)
printf("\n Change in Enthalpy = %d Nm",dH)
```

Scilab code Exa 9.2 Example 2

```
clc
//Initialization of variables
cv=716
m=15 //kg
cp=1003
T1=20+273 //K
k=1.4
ratio=0.4
//calculations
T2=(T1)*(1/ratio)^(k-1)
P1=95 //kN/m^2
P2=P1*T2/(T1)/ratio
di=cv*(T2-T1)
dU=di*m
dh=cp*(T2-T1)
dH=dh*m
//results
printf("Final temperature = %d K",T2)
printf("\n Final pressure = %d kN/m^2",P2)
printf("\n Change in Internal energy = %d N m",dU)
printf("\n Change in Enthalpy = %d Nm",dH)
//The answers are a bit different due to rounding
    off error.
```

Scilab code Exa 9.3 Example 3

```
clc
//Initialization of variables
k=1.4
R=1773
v=600 //fps
T=660 //K
P=100 //psia
cp=6210
g=32.2
```

```
//calculations
c=sqrt(k*R*T)
M=v/c
rho=k*P*144/c^2
Ps=P*144 + 0.5*(rho)*v^2 *(1+ 0.25*M^2)
Ts= (cp/g *T + v^2 /(2*g))*g/cp
//results
printf("Stagnation pressure = %d lb/ft^2",Ps)
printf("\n Stagnation temperature = %d R",Ts)
disp("Please check the units of the answer.")
```

Scilab code Exa 9.4 Example 4

```
clc
//Initialization of variables
g=32.2
A=0.0218 //ft^2
P1=25.6 //psia
T1=540 //K
k=1.4
R=1715
//calculations
G=g*A*P1*144/sqrt(T1) *sqrt(k/R *(2/(k+1))^((k+1)/(k
    -1)))
//results
printf("Flow rate  = %.2f lb/s",G)
```

Scilab code Exa 9.5 Example 5

```
clc
//Initialization of variables
P1=50 //psia
T1=540 //K
```

```
g=32.2
R=1715
k=1.4
P3=13.5 //psia
A2=0.0218 //ft^2
cp=6000
//calculations
Pc=0.528*P1
V32=R*T1/g *k/(k-1) *(1- (P3/P1)^((k-1)/k))
V3=sqrt(V32*2*g)
G3=g*A2*P1*144/sqrt(T1) *sqrt(k/R *(2/(k+1))^((k+1)
   /(k-1)))
T3= T1 - V3^2 /(2*cp)
gam3= g*P3*144/(R*T3)
gam2= (Pc/P3 *gam3^k )^(1/k)
V2=G3/gam2/A2
T2= (V3^2 -V2^2)/(2*cp) + T3
A3=G3/gam3/V3
D3= sqrt(4/%pi *A3)
G2=G3
//results
printf("\n velocity at section 3 = %d fps",V3)
printf("\n Flow rate at section 3 = %.3f lb/s",G3)
printf("\n temperature at section 3  = %d R",T3)
printf("\n velocity at section 2 = %d fps",V2)
printf("\n Flow rate at section 2 = %.3f lb/s",G2)
printf("\n temperature at section 2  = %d R",T2)
printf("\n Required Diameter = %.2f in",D3*12)
```

Scilab code Exa 9.6 Example 6

```
clc
//Initialization of variables
P1=10 //psia
T1=460+40 //R
```

```
R=1715
k=1.4
V1=1400 //fps
//calculations
rho1=P1/(R*T1)
c1=sqrt(k*R*T1)
M1=V1/c1
P2= P1 * (2*k*M1^2  - (k-1))/(k+1)
V2 =V1*((k-1)*M1^2 +2)/((k+1)*M1^2)
rho2=rho1*V1/V2
T2=P2/rho2/R
P22=122.5
V22=286
T22=328
//results
printf("Pressure at point 2 = %.1f psia and %.1f N/m
    ^2",P2,P22)
printf("\n Velocity at point 2 = %d fps and %d m/s",
    V2,V22)
printf("\n Temperature at point 2 = %d R and %d K",
    T2,T22)
disp("Similarly it can be done for SI units")
```

Scilab code Exa 9.7 Example 7

```
clc
//Initialization of variables
A=140 //in^2
P=48 //lb/in^2
mu=3.78*10^-7
g=32.2
G=100 //lb/s
p=80 //lb/in^2
T=65+460 //R
k=1.4
```

```
R=1715
//calculations
Rh=A/P /12
R1=G*4*Rh/ (mu*g*A/144)
R2=R1
f=0.0083
gam1=p*g*144/(R*T)
V1=G*144/gam1/A
c=sqrt(k*R*T)
M1=V1/c
M2=1/sqrt(k)
D=4*Rh
L= ((1-M1^2 /M2^2)/(k*M1^2) - 2*log(M2/M1) )*D/f
Ln=500 //ft
P2=sqrt((p*144)^2 - G^2 *R*T/(g^2 *(A/144)^2 *f*Ln/D
    ))
Pa=12.2
//results
printf("Max. length = %d ft",L)
printf("\n Pressure required = %.1f psia",P2/144 -Pa
    )
```

Scilab code Exa 9.8 Example 8

```
clc
//Initialization of variables
G=100 //lb/s
g=32.2
V2=300 //fps
V1=250 //fps
//calculations
Qh= (V2^2 -V1^2)/(2*g)
Q=Qh*G
//results
printf("Thermal energy added = %d ft lb/s",Q)
```

Scilab code Exa 9.9 Example 9

```
clc
//Initialization of variables
gam1=0.41
g=32.2
V1=250 //fps
R1=8.2*10^6
f=0.0083
A=0.97 //ft^2
G=100 //lb/s
k=1.4
P=80 //lb/in^2
ratio=0.8
R=1715
//calculations
rho1=gam1/g
X = G^2 /(gam1*A)^2 + 2*k/(k-1) *(P*144/rho1)
P2=(k-1)/2/k *(X*ratio*rho1 - G^2 /(g^2 *A^2 *ratio*
    rho1))
L=563 //ft
rho2=ratio*rho1
V2=G/(rho2*g*A)
T2=P2/(rho2*R)
//results
printf("Length = %d ft",L)
printf("\n velocity = %d fps",V2)
printf("\n Temperature = %d R",T2)
```

Chapter 10

new10

Scilab code Exa 10.1 Example 1

```
clc
//Initialization of variables
nu=0.001 //ft^2 /s
L=1.5 //ft
U=2 //ft/s
s=0.925
ro=1.94
b=6
//calculations
R=L*U/nu
Cf=1.328/sqrt(R)
Ff=Cf*s*ro*U*b/12 *L
delta=4.91 *L/sqrt(R)
T0=0.332*nu*s*ro*U/L *sqrt(R)
//results
printf("Friction drag = %.3f lb",Ff)
printf("\n Thickness of boundary layer = %.4f ft",
   delta)
printf("\n Shear stress = %.4f lb/ft^2",T0)
//Similar calculations are done for SI units case
```

Scilab code Exa 10.2 Example 2

```
clc
//Initialization of variables
nu=0.00015 //ft^2/s
L=35 //ft
U=88 //fps
g=32.2 //ft/s^2
b=10 //ft
w=8 //ft
rho=0.0725
//calculations
R=L*U/nu
Cf=0.455 /(log10(R))^2.58
B=2*b + w
Ff=Cf*rho/g *U^2 /2 *L*B
Rx=R/10^5
delta=L*0.377 /(b* Rx^(0.2))
T0=0.0587 *rho/g *U^2 /2 *(nu/(L*U))^(0.2)
//results
printf("Frictional drag = %.1f lb",Ff)
printf("\n Thickness of boundary layer = %.3f ft",
   delta)
printf("\n Shear stress = %.4f lb/ft^2",T0)
```

Scilab code Exa 10.3 Example 3

```
clc
//Initialization of variables
nu=0.0000166 //ft^2 /s
U=5.06 //fps
L=50 //ft
```

```
g=32.2
dia=10 //ft
//calculations
R=L*U/nu
Cf=0.0028
Ff=Cf*64/g *U^2 /2 *%pi*dia*L
Rx=R/L
ec=26*nu/U *Rx^(0.25)
Rx2=Rx*L/2
T02=0.0587*U^2 /2 /(Rx2)^(0.2)
delta2=60*nu/sqrt(T02)
//results
printf("Friction drag = %d lb",Ff)
printf("\n Critical roughness = %.4f ft",ec)
printf("\n height of roughness = %.4f ft",delta2)
```

Scilab code Exa 10.4 Example 4

```
clc
//Initialization of variables
Cd=0.45
rho=0.0725/32.2
V=88 //fps
A=8*10
//calculations
Fd=Cd*rho*V^2 /2 *A
Drag2=23
D=Fd-Drag2
//results
printf("Pressure drag = %d lb",D)
```

Scilab code Exa 10.5 Example 5

```
clc
//Initialization of variables
Cd=0.2
D=8.5 //in
V=412 //fps
nu=1.57*10^-4
//calculations
Vt=480 //fps
//results
printf("Free fall velocity = %d fps",Vt)
```

Scilab code Exa 10.6 Example 6

```
clc
//Initialization of variables
nu=1.15*10^-5 //m^2/s
D=2*10^-3 //m
V=15 //m/s
T=-20 //C
//calculations
R=D*V/nu
f=0.2 *V/D *(1+T/R)
//results
printf("Frequency of oscillation = %d Hz",f)
```

Scilab code Exa 10.7 Example 7

```
clc
//Initialization of variables
n=90 //rpm
R=2
rho=0.0765/32.2
B=25
```

```
U=120 //fps
//calculations
vt=2*%pi*R*n/60
T=2*%pi*R*vt
Fl=rho*B*U*T
theta=asind(-T/(4*%pi*R*U))
//results
printf("Value of circulation = %d ft62/s",T)
printf("\n Transverse or lift force = %d lb",Fl)
printf("\n Position of stagnation points = %.1f"
    ,180-theta)
```

Scilab code Exa 10.8 Example 8

```
clc
//Initialization of variables
B=36 //ft
c=6 //ft
Cl=0.8
tau=0.175
rho=0.001756
V=300 //fps
//calculations
alphai=Cl/(%pi*B/c) *(1+tau) *180/%pi
alpha=5.4
lift=-5.6 //degrees
alphao=alpha-alphai
alphaod=alphao-lift
alphaor=alphaod*%pi/180
eta=Cl/(2*%pi*alphaor)
Fl=Cl*rho*V^2 /2 *B*c
Fd=0.047/Cl *13680
HP=Fd*V/550
//results
printf("Friction coefficient = %.3f ",eta)
```

```
printf("\n weight of the wing = %d lb",Fl)
printf("\n Horsepower required = %d hp",HP)
```

Scilab code Exa 10.9 Example 9

```
clc
//Initialization of variables
k=1.4
R=287
T=249 //K
v=600 //m/s
d=0.2 //m
//calculations
c=sqrt(k*R*T)
M=v/c
Cd=0.62
rho=47.22*10^3 /(R*T)
Fd=Cd*rho*v^2 /2 *%pi*d^2 /4
//results
printf("Drag = %d N",Fd)
```

Chapter 11

new11

Scilab code Exa 11.1 Example 1

```
clc
//Initialization of variables
y=3.4 //ft
n=0.016
//calculations
A=(10+2*y)*y
P=10+ 2*sqrt(5) *y
Rh=A/P
f=116*n^2 /Rh^(1/3)
e= 14.8*Rh/ 10^(1/2/sqrt(f))
//results
printf("absolute roughness of pipe = %.4f ft",e)
```

Scilab code Exa 11.2 Example 2

```
clc
//Initialization of variables
y=1.495 //ft
```

```
Q=14 //cfs
g=32.2
//calculations
yc=(Q^2 /g *2)^(1/5)
//results
printf("yc = %.2f ft is greater than uniform flow
   depth. Hence flow is supercritical",yc)
```

Scilab code Exa 11.3 Example 3

```
clc
//Initialization of variables
q=27/4
g=32.2
Q=27 //cfs
d=2 //ft
dz1=0.3 //ft
//calculations
yc=(q^2 /g)^(1/3)
V2=Q/(4*yc)
V1=Q/(4*d)
dz = d+ V1^2 /(2*g) - V2^2/(2*g) - yc
y2=1.6 //ft
drop = d-(y2+dz1)
dz2=0.6 //ft
up=2.12 //ft
down=0.66 //ft
//results
printf("yc = %.2f ft. Since, depth is greater than
   critical depth. the flow is subcritical",yc)
printf("\n Drop in water height = %.2f ft",drop)
printf("\n Drop upstream = %.2f ft and Downstream =
   %.2f ft",up,down)
```

Scilab code Exa 11.5 Example 5

```
clc
//Initialization of variables
y0=2.17 //ft
q=400/10
g=32.2
d=4.8 //ft
S0=0.0016
//calculations
yc=(q^2 /g)^(1/3)
y2=y0/2 *(-1 + sqrt(1+ 8*q^2 /(g*y0^3)))
y1=d/2 *(-1 + sqrt(1+ 8*q^2/(g*d^3)))
E1=y0 + (q/yc)^2 /(2*g)
E2= y1+ (q/y1)^2 /(2*g)
Vm=0.5*(q/yc + q/y1)
Rm=0.5*(y0/1.434 + y1/1.552)
S=(0.013*Vm/(1.49*Rm^(2/3)))^2
dx=(E1-E2)/(S-S0)
E1d=E2
E2d=d+ (q/4.8)^2 /(2*g)
HPl=62.4*q*10*(E1d-E2d)/550
//results
printf("Power loss = %.2f ",HPl)
//The answer is a bit different from the textbook
   due to rounding off error
```

Scilab code Exa 11.6 Example 6

```
clc
//Initialization of variables
y1=[1.5 1.48]
```

```
V1=[2.22 2.29]
d=1.2
//calculations
q=y1.*V1
V2=q/d
Vm=[2.5 2.56]
Rh1=[0.9 0.89]
Rh2=[0.88 0.78]
Rhm=(Rh1+Rh2)/2
S=(q.*Vm/ Rhm.^(2/3)).^2
dx=[358 226]
yavg=(y1(1) + y1(2))/2
qavg=(q(1) + q(2))/2
B=4.5
Q=qavg*B
//results
printf("Flow rate = %.1f m^3/s",Q)
```

Chapter 12

new12

Scilab code Exa 12.1 Example 1

```
clc
//Initialization of variables
P1=10 //psia
Q=0.6 //cfs
A1=0.0491 //ft^2
g=32.2
V=39.2//fps
A0=0.0218 //ft^2
d1=2 //in
d2=3 //in
//calculations
Phead=P1*144/62.4
V1=Q/A1
V2i= sqrt(2*g*(Phead + V1^2 /(2*g)))
Cv=V/V2i
A2=Q/V
Cc=A2/A0
Cd=Cc*Cv
hL=(1/Cv^2 -1)*(1- (d1/d2)^4)*V^2 /(2*g)
//results
printf("Cc = %.2f ",Cc)
```

```
printf("\n Cd= %.2f",Cd)
printf("\n Cv= %.2f",Cv)
printf("\n Head loss = %.2f ft",hL)
```

Scilab code Exa 12.2 Example 2

```
clc
//Initialization of variables
d=2 //in
g=32.2
d1=3 //in
k=1.06
//calculations
A2=%pi/4 *d^2 /144
dp=d/12
Q=k*A2*sqrt(2*g*dp)
A=%pi/4 *(d1/12)^2
V1=Q/A
K2=1.04
Q2=K2/k *Q
//results
printf("Flow rate = %.4f cfs",Q2)
```

Scilab code Exa 12.3 Example 3

```
clc
//Initialization of variables
P1=700 //kN/m^2
P2=400 //kN/m^2
D2=12.5 //cm
D1=25 //cm
C=0.985
g=9.81
```

```
R=287 //m^2/s^2 K
T=273+20 //K
//calculations
Pr=P2/P1
Dr=D2/D1
Y=0.72
gam1=P1*g/(R*T)
G=C*Y*%pi/4 *(D2/100)^2 *sqrt(2*g*gam1*(P1-P2)/(1-
   Dr^4))
//results
printf("Weight flow rate = %.4f kN/s",G)
```

Scilab code Exa 12.4 Example 4

```
clc
//Initialization of variables
V=3 //fps
y=1 //ft
L=4 //ft
//calculations
H= (V*y/3.33)^(2/3)
P=L-H
//results
printf("Height of weir = %.2f ft",P)
```

Chapter 13

new13

Scilab code Exa 13.1 Example 1

```
clc
//Initialization of variables
ken=0.5
kex=0.2
f=0.0018
l=10 //ft
dia=3 //in
z1=8
z2=5
//calculations
x1=ken+kex+f*l*12/dia
t=35.5*2/3 *(z1^(3/2) - z2^(3/2))
//results
printf("Time reqired = %d s",t)
```

Scilab code Exa 13.2 Example 2

```
clc
```

```
//Initialization of variables
disp("For steady state, dV/dt =0")
Q=1600/449
A2=0.1963
g=32.2
rp2=2000
//calculations
V2=Q/A2
hp1=32*V2^2 /(2*g) -50
hp2=hp1*(rp2/1650)^2
hpf=169 //ft
Q=4.1 //cfs
//results
printf("Steady state flow rate = %.2f cfs",Q)
```

Scilab code Exa 13.3 Example 3

```
clc
//Initialization of variables
kl=0.5
f=0.02
L=15 //ft
D=0.1 //ft
k=3.5
g=9.81
H=2//ft
//calculations
k=kl+f*L/D
V0=sqrt(2*g*H/(1+k))
Q=[0.25 0.5 0.75]
V=V0*Q
Vfun=(2.95+V)./(2.95-V)
lnVfun=log(Vfun)
t=1.129*lnVfun
//results
```

```
disp(t)
disp("Similarly, it can be calculated for L=150,1500 ft")
```

Scilab code Exa 13.4 Example 4

```
clc
//Initialization of variables
Q=30 //cfs
r=2 //ft
cp=3200
rho=1.94
Q2=10 //cfs
z=300 //ft
//calculations
V=Q/(%pi*r^2)
ph=rho*cp*V/144
phd=4000/cp /(2*r) *ph
dV=(Q2-Q)/(%pi*r^2)
dph=-rho*cp*dV/144
ph3=rho*cp*V/3 /144
ph4=ph3*z*2/cp
//results
printf("Water hammer pressure= %.1f psi",ph)
printf("\n Water hammer pressure in case 2= %.1f psi",phd)
printf("\n Water hammer pressure in case 3= %.1f psi",dph)
printf("\n Pressure at valve in case 4 = %.1f psi",ph3)
printf("\n Pressure at 300 ft from reservoir = %.2f psi",ph4)
```

Chapter 14

new14

Scilab code Exa 14.1.a Example 1

```
clc
//Initialization of variables
g=9.81 //kN/m^3
Q=3.2 //m^3/s
h=25 //m
eta=0.82
//calculations
bp= g*Q*h/eta
//results
printf("Brake power = %d kW",bp)
```

Scilab code Exa 14.1.b Example 2

```
clc
//Initialization of variables
D1=50
n1=1450
n2=1200
```

```
D2=80
Q1=3.2 //cfs
h1=25 //m
g=9.81 //kN/m^3
eta=0.82
//calculations
h2=h1*(D2/D1)^2 *(n2/n1)^2
Q2=Q1*(D2/D1)^3 *(n2/n1)
bp=g*Q2*h2/eta
h1=82 //ft
Q1=50700 //gpm
h2=143.8 //ft
Q2=171800 //gpm
Ns1=n1*sqrt(Q1) /h1^(3/4)
Ns2=n2*sqrt(Q2) /h2^(3/4)
//results
printf("Brake power = %d kW",bp)
printf("\n Pumps are homologous. We expect them to
    have same specific speed and their speeds are %.1
    f and %.1f",Ns1,Ns2)
disp("14.1c is included in this example itself")
```

Chapter 15

new15

Scilab code Exa 15.1 Example 1

```
clc
//Initialization of variables
z2=500//ft
z1=300//ft
D=[1 1.5 2 2.5 3 4 6]
g=32.2
gam=62.4
//calculations
Dj=D/12
Vj=sqrt((z2-z1)*2*g./(1.04 + 640.*Dj.^4))
Aj=%pi/4 *Dj.^2
Q=Aj.*Vj
Pjet=gam*Q.*Vj.^2 /(2*g) /550
Pj=max(Pjet)
for i=1:length(Pjet)
    if(Pjet(i) ==Pj)
        break
    end
end
diameter=D(i)
//results
```

```
printf("Thus a pipe of %d in will be the optimum",
    diameter)
```

Scilab code Exa 15.2 Example 2

```
clc
//Initialization of variables
phi=0.46
g=32.2
k=0.44
cv=0.98
d=10 //in
A=0.545 //ft^2
beta=160 //degrees
//calculations
u=phi*sqrt(2*g)
V1=cv*sqrt(2*g)
gQ=62.4*A*V1
T=d/2 *gQ/g *(1 -cosd(beta) /sqrt(1+k) )*sqrt(2*g)*(
    cv-phi)
Power=T*2*u/d
//results
printf("Torque required = %d ft lb",T)
printf("\n Power transferred = %d ft lb/s",Power)
Pi=gQ
He=Power/Pi
printf("\n Hydraulic efficiency = %.2f",He)
v1=V1-u
v2=v1/(sqrt(1+k))
hl=k*v2^2 /(2*g)
printf("Head loss in bucket friction = %.4f",hl*100)
Hn=(1/cv^2 -1)*V1^2 /(2*g)
printf("\n Head loss in  nozzle = %.4f",Hn*100)
V2cos=u+v2*cosd(beta)
V2sin=v2*sind(beta)
```

```
alpha=acot(V2cos/V2sin)
V2=V2sin/sin(alpha)
Hd=V2^2/(2*g)
printf("\n Head loss at discharge = %.2f",Hd*100)
Htotal=Hd+Hn+hl
printf("\n Total head loss = %.2f",Htotal*100)
```

Scilab code Exa 15.3.a Example 3

```
clc
//Initialization of variables
cv=0.98
g=32.2
h=1320 //ft
A=0.196 //ft^2
eta=0.85
ne=400
phi=0.45
//calculations
V=cv*sqrt(2*g*h)
Q=A*V
bhp=eta*62.4*Q*h/550
ns=ne*sqrt(bhp) /h^(5/4)
u=phi*sqrt(2*g*h)
D=u*60/%pi/ne
//results
printf("Pitch diameter = %.2f ft",D)
```

Scilab code Exa 15.3.b Example 4

```
clc
//Initialization of variables
cv=0.98
```

```
g=32.2
h=1320 //ft
A=0.196 //ft^2
eta=0.85
ne=400
phi=0.45
//calculations
V=cv*sqrt(2*g*h)
Q=A*V/3
bhp=eta*62.4*Q*h/550
ne2=600
ns1=ne2*sqrt(bhp) /h^(5/4)
D=2500/ne2
Dj=sqrt(Q*4/V/%pi)
//results
printf("Jet diameter = %.3f ft",Dj)
printf("\n Specific speed = %.2f ",ns1)
printf("\n Pitch Diameter = %.2f ft",D)
printf("\n Operating speed = %d rpm",ne2)
```

Chapter 16

new16

Scilab code Exa 16.2 Example 2

```
clc
//Initialization of variables
ns=20
eta=0.925
etah=0.94
BD=0.1
phie=0.72
g=32.2
alpha2=90 //degrees
//calculations
Cr=ns^2 /(67100*phie^2 *BD*eta)
c1cos=etah/(2*phie)
alpha=atan(Cr/c1cos)
C1=Cr/sin(alpha)
beta1=acotd((C1*cos(alpha) -phie)/(C1*sin(alpha)))
//results
printf("Alpha = %.2f degrees",alpha*180/%pi)
printf("\n Beta = %.2f degrees",beta1)
disp("part b")
h=402
n=600 //rpm
```

```
bhp=3600
ns=n*sqrt(bhp)/h^(5/4)
D=153.2*phie*sqrt(h)/n
B=BD*D
Dt=D*0.735
Ac=0.95*%pi*D*B
Vr=Cr*sqrt(2*g*h)
Q=Ac*Vr
//results
printf("\n Breadth= %.3f ft",B)
printf("\n depth D= %.3f ft",D)
printf("\n velocity Vr= %d ft/s",Vr)
printf("\n Flow rate Q= %.1f cfs",Q)
```

Scilab code Exa 16.3 Example 3

```
clc
//Initialization of variables
ns=70
z1=10 //ft
z2=5000 //ft
//calculations
P1=12.2*144/62.4
P2=0.26*144/62.4
sigmac=0.31
h=(P1-P2-z1)/sigmac
//results
printf("Max permissible head to assure against
    cavitation = %d ft",h)
```

Scilab code Exa 16.4 Example 4

```
clc
```

```
//Initialization of variables
Q=600 //cfs
z=350 //ft
eta=0.9
//calculations
power=62.4*Q*z*eta/550
rpm=75
n=2
ns=rpm*sqrt(power/n) /z^(5/4)
phi=0.45
D=153.3*sqrt(z) *phi/rpm
rpm2=600
ns2=rpm2*sqrt(power/n) /z^(5/4)
//results
printf("For two turbines, ns= %.2f",ns)
printf("\n For francis turbines, ns= %d ",ns2)
```

Chapter 17

new17

Scilab code Exa 17.1.b Example 2

```
clc
//Initialization of variables
ne=600
gpm=1600
Ns=500
Head=900 //ft
//calculations
h=(ne*sqrt(gpm) /Ns)^(4/3)
n=Head/h
//results
printf("No. of stages = %d",n+1)
```

Scilab code Exa 17.1 Example 1

```
clc
//Initialization of variables
Ns=500
h=900 //ft
```

```
Q=1600 //gpm
//calculations
ne=Ns*h^(3/4) /sqrt(Q)
//results
printf("Minimum rotative speed = %d rpm",ne)
```

Scilab code Exa 17.2 Example 3

```
clc
//Initialization of variables
ne=600
gpm=2000
h=150
num=2
//calculations
ns=ne*sqrt(gpm) /h^(3/4)
gpm2=num*gpm
h2=num^2 *h
Ns=2*ne*sqrt(gpm2) /h2^(3/4)
Ne2=Ns*(h/2)^(3/4) /sqrt(gpm)
//results
printf(" Specific speed in case1 = %d ",ns)
printf("\nFlow rate in case 2 = %d gpm",gpm2)
printf("\n Head in case 2 = %d ft",h2)
printf("\n Specific speed in case 2 = %d ",Ns)
printf("\n required operating speed in case 2 = %d
   rpm",Ne2)
```

Scilab code Exa 17.3 Example 4

```
clc
//Initialization of variables
ne=600/2
```

```
gpm=1450
h=140
NPSH=10.4
//calculations
Ns=gpm*sqrt(ne) /h^(3/4)
sigmac=NPSH/h
zsmax=-3 //ft
//results
printf("Sigma C for the pump = %.4f",sigmac)
printf("\n Position of pump = %d ft",zsmax)
```

Scilab code Exa 17.4 Example 5

```
clc
//Initialization of variables
ne=600
gpm=84500
h=225
f=0.95
phie=1.1
g=32.2
//calculations
Ns=ne*sqrt(gpm) /h^(3/4)
u2=phie*sqrt(2*g*h)
D=153.2*phie*sqrt(h) /ne
D0=1.06*D*12 //in
B=0.155*D0*12 //in
De=0.6*D0
u0=1.06*u2
Vm2=0.15*u0
Area=0.95*%pi*D/144 *B
Q=Area*Vm2
//results
printf("Specific speed =%d ",Ns)
printf("\n Flow rate = %d cfs",Q)
```

```
printf("\n Eye diameter = %.1f in",De)
```