Scilab Textbook Companion for Basic Fluid Mechanics by Peerless[1]

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Book Description

Title: Basic Fluid Mechanics

Author: Peerless

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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 2

Similarity

Scilab code Exa 2.1 Force applied

```
clc
//initialisation of variables
clear
r= 4
l1= 4 //units
l2= 10 //units
//CALCULATIONS
sxy= (4/r)
sxy1= l1^2
sxy2= l2^2
//RESULTS
printf ('x^2+4*y^2 = %.f ',sxy)
printf ('\n x^2+4*y^2 = %.f ',sxy1)
printf ('\n x^2+4*y^2 = %.f ',sxy2)
```

Scilab code Exa 2.3 force required

```
clc
```

```
//initialisation of variables
clear
vo= 10 //ft/sec
a= 0.5 //ft^-1
b= 1 //ft
x= -2 //ft
y= 2 //ft
b1= 2
a1= 3/5 //ft
//CALCULATIONS
Vx= vo/(a*x^2+b)
Vy= -2*a*b*vo*x*y/(a*x^2+b)^2
V= sqrt(Vx^2+Vy^2)
fx= -2*a*b^2*vo^2*x/(a*x^2+b)^3
fy= 2*a*b^2*vo^2*y*(b-a*x^2)/(a*x^2+b)^4
f= sqrt(fx^2+fy^2)
r= b1^2/a1
f1= f*r
//RESULTS
printf ('Vx = %.2f ft/sec',Vx)
printf ('\n Vx = %.2f ft/sec',Vy)
printf ('\n V = %.2f ft/sec',V)
printf ('\n fx = %.2f ft/sec^2',fx)
printf ('\n fy = %.2f ft/sec^2',fy)
printf ('\n f = %.2f ft/sec^2',f)
printf ('\n r = %.2f in the present case',r)
printf ('\n f1 = %.2f ft/sec^2',f1)
```

Scilab code Exa 2.4 force at the end

```
clc
//initialisation of variables
clear
r= 1/5
b1= 2 //ft
```

```
a1= 3/5 //ft
//CALCULATIONS
r= (a1*b1)^2*r
//RESULTS
printf ('ratio of resultant forces acting on
   coorresponding fluid elements = %.2f ',r)
```

Scilab code Exa 2.5 air speed

```
clc
//initialisation of variables
clear
vos= 70 //ft/sec
as= 78 //ft
am= 72 //ft
ls1= 6 //ft
lm= 2 //ft
um= 386 //ft/sec
us= 372 //ft/sec
dm= 0.4
//CALCULATIONS
vom= vos*as*ls1*um/(am*lm*us)
Ds= dm*(am/as)*(us/um)^2
//RESULTS
printf ('Air speed = %.f ft/sec',vom)
printf ('\n Ds = %.3f lbf',Ds)
```

Scilab code Exa 2.6 ratio of resultant forces

```
clc
//initialisation of variables
clear
vom= 236 //ft/sec
```

```
as= 0.072 //ft
am= 62.4 //ft
ls1= 2 //ft
lm= 8 //ft
um= 248 //ft/sec
us= 3.86 //ft/sec
r= 0.4/3.3
//CALCULATIONS
voh= vom*as*ls1*um/(am*lm*us)
Ds= r*(as/am)*(um/us)^2*(ls1/lm)*(lm-ls1)
//RESULTS
printf ('Air speed = %.2f ft/sec',voh)
printf ('\n Drag force = %.3f lbf',Ds)
```

Scilab code Exa 2.7 Temperature a exit

```
clc
//initialisation of variables
clear
To1= 540 //R
po3= 12.6 //lbf/in^2
l3= 3 //ft
po1= 14.7 //lbf/in^2
l1= 1 //ft
vo1= 500 //ft/sec
r= 0.83
P1= 1 //lbf/in^2
//CALCULATIONS
To3= To1*(po3*l3/(po1*l1))^r
Vo3= vo1*sqrt(To3/To1)
P3= P1*po3*l3/(po1*l1)
//RESULTS
printf ('To3 = %.f R',To3)
printf ('\n Vo3 = %.f ft/sec',Vo3)
printf ('\n P3 = %.2f lbf/ft',P3)
```

Chapter 3

Dimensional Analaysis

Scilab code Exa 3.1 dimensions of g

```
clc
//initialisation of variables
clear
g= 32.2 //ft/sec^2
t= 1 //hr
g1= 32.2 //ft/sec^2
g2= 32.2 //lbm ft/lbf
u= 2.4*10^-5 //lbf sec/ft^2
//CALCULATIONS
q2= g*(t*60*60)^2
go= g*(t*60*60)^2
q3= g/g2
u1= u/(t*60*60)
//RESULTS
printf ('q2 = %.2e lbm ft/lbf hr^2',q2)
printf ('\n go = %.2e lbm ft/lbf hr^2',go)
printf ('\n go = %.f slug ft/lbf sec^2',q3)
printf ('\n viscosity = %.2e lbf hr/ft^2',u1)
```

Scilab code Exa 3.2 dimensions of vectors

```
clc
//initialisation of variables
clear
g= 32.2 //ft/sec^2
m= 1 //lb
//CALCULATIONS
m1= g/m
//RESULTS
printf ('1 lbf/sec ft^2 = %.1f lbm/ft sec',m1)
```

Scilab code Exa 3.5 dimensions of velocity

```
clc
//initialisation of variables
clear
n1=1
n2= 3
n3=2
//CALCULATIONS
a1= -n1
a2= -n3
a3= -n1-a2+3*a1
b1= -n1
b2= -n1
b3= n1+3*b1-b2
//RESULTS
printf ('a1 = %.f ',a1)
printf ('\n a2 = %.f ',a2)
printf ('\n a3 = %.f ',a3)
printf ('\n b1 = %.f ',b1)
printf ('\n b2 = %.f ',b2)
printf ('\n b3 = %.f ',b3)
```

Chapter 5

Control Volume Analysis

Scilab code Exa 4.1 ex 1

```
clc
//initialisation of variables
clear
w= 20 //lbm/sec
sh= 0.004
m1= 0.12 //lbm/sec
m2= 12.2 //lbm/sec
m3= 0.130 //lbm/sec
//CALCULATIONS
mw1= w/((1/sh)+1)
ma1= w-mw1
ma4= ma1-m2
mw4= mw1+m1-m3
mr= ma4+mw4
sh1= mw4/ma4
//RESULTS
printf ('mw1 = %.4f lbm/sec',mw1)
printf ('\n ma1 = %.2f lbm/sec',ma1)
printf ('\n ma4 = %.2f lbm/sec',ma4)
printf ('\n mw4 = %.2f lbm/sec',mw4)
printf ('\n mr = %.2f lbm/sec',mr)
```

```
printf ('\n specific humidity = %.5f lbm/sec',sh1)
```

Scilab code Exa 5.2 ex 2

```
clc
//initialisation of variables
clear
w= 62.4 //lbf/ft^3
g= 32.2 //ft/sec^2
v= 86.5 //ft/sec
d2= 3 //in
d1= 6 //in
dp= 50 //lbf/in^2
//CALCULATIONS
Fb= -((%pi*(w/g)*v^2*(1/d1)^2*(1-(d2/d1)^2)*0.25)-dp
   *144*(%pi/4)*(1/d2)^2)
//RESULTS
printf ('Load on the bolts = %.f lbf',Fb)
```

Scilab code Exa 5.3 ex 3

```
clc
//initialisation of variables
clear
F1= 237 //lb
dp= 50 //lbf/in^2
D= 6 //in
//CALCULATIONS
F2= dp*144*(%pi/4)*(D/12)^2
Fb= F1-F2
//RESULTS
printf ('Load on the bolts = %.f lbf',Fb)
```

Scilab code Exa 5.5 ex 5

```
clc
//initialisation of variables
clear
w1= 0.0286 //lbm/ft^3
v= 2500 //ft/sec
A= 2.5 //ft^3
k= 0.015
p2= 700 //lbf/ft^2
p1= 628 //lbf/ft^2
v2= 3500 //ft/sec
g= 32.17 //ft/sec^2
//CALCULATIONS
ma= w1*v*A
mf= k*ma
mt= ma+mf
F= (p2-p1)*A+(mt*v2/g)-(ma*v/g)
//RESULTS
printf ('air mass flow rate = %.2f lbm/sec',ma)
printf ('\n Fuel flow rate = %.2f lbm/sec',mf)
printf ('\n Fuel flow rate at station 2 = %.2f lbm/
    sec',mt)
printf ('\n Thrust force = %.f lbf',F)
```

Chapter 6

Steady one dimensional reversible flow

Scilab code Exa 6.1 ex 1

```
clc
//initialisation of variables
clear
g= 32.2 //ft/sec^2
h= 4 //ft
d2= 0.16 //ft
d1= 0.3 //ft
dp= 12.6 //lbf/in^2
//CALCULATIONS
Q= (%pi/4)*sqrt(2*g*dp*h/((1/d2^4)-(1/d1^4)))
//RESULTS
printf ('Volumetric flow rate = %.2f ft^3/sec',Q)
```

Scilab code Exa 6.2 ex 2

```
clc
```

```
//initialisation of variables
clear
w= 0.0765 //lbm/ft^3
v1= 120 //ft/sec
g= 32.2 //ft/sec^2
//CALCULATIONS
dp= w*v1^2/(2*2*g)
//RESULTS
printf ('Difference in pressure= %.2f lbf/ft^2',dp)
```

Scilab code Exa 6.3 ex 3

```
clc
//initialisation of variables
clear
r=1.4
g= 32.2 //ft/sec^2
R= 53.3 //lbf ft/lbm
T1= 760 //R
p2= 2 //lbf/in^2
p1= 3 //lbf/in^2
//CALCULATIONS
V2= sqrt(2*r*R*g*T1*(1-(p2/p1)^((r-1)/r))/(r-1))
//RESULTS
printf ('Velocity in working section = %.f ft/sec',
   V2)
```

Scilab code Exa 6.4 ex 4

```
clc
//initialisation of variables
clear
r= 1.4
```

```
g= 32.2 //ft/sec^2
R= 53.3 //lbf ft/lbm
T= 32 //C
T1= 2000 //R
r1= 1.32
p= 1440 //lbf/in^2
v1= 1.2306 //ft^3/lbm
v2= 1.2546 //ft^3/lbm
bm= 3.13*10^5 //lbf/in^2
w= 62.4 //lbf/ft^3
//CALCULATIONS
a1= sqrt(r*R*(460+T)*g)
a2= sqrt(r1*R*T1*g)
r2= p/(v1-v2)
a3= sqrt(-g*(v1+v2)^2*0.5^2*r2)
a4= sqrt(bm*144*g/w)
//RESULTS
printf ('Acoustic veloctiy = %.f ft/sec',a1)
printf ('\n Acoustic veloctiy = %.f ft/sec',a2)
printf ('\n Acoustic veloctiy = %.f ft/sec',a3)
printf ('\n Acoustic veloctiy = %.f ft/sec',a4)
```

Scilab code Exa 6.5 ex 5

```
clc
//initialisation of variables
clear
r= 1.4
ma2= 2.5 //ft/sec
g= 32.17 //ft/sec^2
p2= 1 //lbf/in^2
ps= 17.08 //lbf/in^2
ps2= 75 //lbf/in^2
Ts= 720 //R
R= 53.3 //lbf ft/lbm
```

```
A= 4 //ft^2
ps3= 0.4 //lbf/in^2
A2= 0.685 //ft^2
P= 5 //per cent
//CALCULATIONS
R1= (1+0.5*(r-1)*ma2^2)^(r/(r-1))
R2= (2*(r/(r-1))*(p2/ps)^(2/(r))*(1-(p2/ps)^((r-1)/r
    )))^0.5
m2= R2*ps2*144*(g/(R*Ts))^0.5*0.1
m= m2*A
At= A*R2/A2
m1= m*(1-(P/100))
mrp= (1-(P/100))*R2
//RESULTS
printf ('Mass flow rate= %.1f lbm/sec',m)
printf ('\n Area of throat= %.3f ft^2',At)
printf ('\n Mass flow rate= %.1f lbm/sec',m1)
printf ('\n Mass flow rate parameter = %.4f',mrp)
```

Scilab code Exa 6.7 ex 7

```
clc
//initialisation of variables
clear
r1= 10 //ft
r2= 0.2 //miles
w= 0.0765 //lbm/ft^2
g= 32.2 //ft/sec^2
V1= 1 //ft/sec
//CALCULATIONS
k= r2*5280*V1
dp= w*k^2*10*((1/r1)^2-(1/(5280*r2))^2)/(2*g)
//RESULTS
printf ('k = %.f ft^2/sec',k)
printf ('\n pressure difference = %.1f lbf/ft^2',dp)
```

Scilab code Exa 6.9 ex 9

```
clc
//initialisation of variables
clear
w= 12 //ft
q= 300 //ft^3/sec
h= 10 //ft
g= 32.2 //ft/sec^2
R= 2.6
//CALCULATIONS
hc= ((q/12)^2/g)^(1/3)
r= h/hc
h1= hc*(((h/hc)+0.5*(hc/h)^2)-0.5*R^2)
//RESULTS
printf ('hc = %.2f ft',hc)
printf ('\n stream depth = %.2f ft',h1)
```

Scilab code Exa 6.10 ex 10

```
clc
//initialisation of variables
clear
Q= 400 //ft^3/sec
b1= 25 //ft
b2= 20 //ft
h1= 6 //ft
z1= 2.5 //ft
z2= 3.3 //ft
g= 32.2 //ft/sec^2
//CALCULATIONS
```

```
hc1= (Q^2/(g*b1^2))^(1/3)
hc2= (Q^2/(g*b2^2))^(1/3)
r= (hc1/hc2)*((h1/hc1)+0.5*(hc1/h1)^2)+((z1-z2)/hc2)
//RESULTS
printf ('hc1 = %.3f ft',hc1)
printf ('\n hc2 = %.3f ft',hc2)
printf ('\n Ratio = %.3f ',r)
```

Chapter 7

Steady one dimensional Irreversible flow

Scilab code Exa 7.1 ex 1

```
clc
//initialisation of variables
clear
r= 1.5
f= 0.025
//CALCULATIONS
r1= (2/f)*(r^2-1)
//RESULTS
printf ('ratio L/D2 = %.f',r1)
```

Scilab code Exa 7.2 ex 2

```
clc
//initialisation of variables
clear
a= 6 //degrees
```

```
r= 1.5
l= 100 //ft
f= 0.025
K= 0.15
//CALCULATIONS
R= r^4-1
R1= cotd(a/2)*(1-(1/r))
p1= f*l
p2= 2.5*(l-p1)/l
p3= (1-r^2)^2
p4= K*p3
pt= p4+p2
//RESULTS
printf ('lowest ratio = %.2f',R)
printf ('\n contribtuion of friction in pipe = %.1f
   lbf/ft^2',p1)
printf ('\n contribtuion of diffuser in pipe = %.3f
   lbf/ft^2',p2)
printf ('\n stagnant pressure drop = %.3f lbf/ft^2',
   p3)
printf ('\n contribtuion of friction in pipe after
   reduction = %.3f lbf/ft^2',pt)
```

Scilab code Exa 7.3 ex 3

```
clc
//initialisation of variables
clear
d= 4 //in
q= 0.5 //ft^3/sec
w= 62.4 //lb/ft^3
u= 2.7*10^-5 //lbf sec/ft^2
e= 0.0005 //ft
g= 32.1 //ft/sec^2
f= 0.0235
```

```
lt= 400 //ft
//CALCULATIONS
V= 4*q/(%pi*(d/12)^2)
Re= w*V*(d/12)/(u*g)
r= e/(d/12)
dz= (V^2/(2*g))*(1.7+f*lt/(d/12))
//RESULTS
printf ('mean flow velocity = %.2f ft/sec',V)
printf ('\n Reynolds number = %.2e',Re)
printf ('\n Relative roughness = %.4f',r)
printf ('\n difference in the levels of water = %.1f
    ft',dz)
```

Scilab code Exa 7.4 ex 4

```
clc
//initialisation of variables
clear
d= 4 //in
v= 6.64 //ft/sec
//CALCULATIONS
Q= %pi*0.25*(d/12)^2*v
//RESULTS
printf ('Flow rate= %.3f ft^3/sec',Q)
```

Scilab code Exa 7.5 ex 5

```
clc
//initialisation of variables
clear
d= 0.366 //ft
i= 12
//CALCULATIONS
```

```
pd= d*i
//RESULTS
printf ('Required pipe diameter = %.2f in',pd)
```

Scilab code Exa 7.6 ex 6

```
clc
//initialisation of variables
clear
Ps1= 1050 //lbf/ft^2
fr= 10.7
p= 36.6 //lbf/ft^2
p1= 195 //lbf/ft^2
fr1= 16
fr2= 1.8
//CALCULATIONS
p2= fr*p
dp= Ps1-p2
lc= dp/p
sp= Ps1+p1-p*(fr1+fr2)
lc1= sp/p
//RESULTS
printf ('Pressure = %.f lbf/ft^2',p1)
printf ('\n pressure difference = %.f lbf/ft^2',dp)
printf ('\n Loss coefficient = %.f ',lc)
printf ('\n Loss coefficient = %.1f ',lc1)
```

Scilab code Exa 7.7 ex 7

```
clc
//initialisation of variables
clear
p1= 50 //lbf/in^2
```

```
R= 96.3 //ft lbf/lbm R
T= 80 //F
p2= 20 //lbf/in^2
r= 1.31
u= 2.34*10^-7 //lbf sec/ft^2
e= 0.00005 //ft
m= 5*10^4 //lbm/sec
d= 1.5 //ft
g= 32.2 //ft/sec^2
f= 0.113
//CALCULATIONS
w1= p1*144/(R*(460+T))
V1= 4*(m/3600)/(%pi*w1*d^2)
Ma1= V1/(r*R*g*(460+T))^0.5
Re= w1*V1*d/(u*g)
dx= (((1/(r*Ma1^2))*10*(1-(p2/p1)^2))+log(p2/p1))*d/
    f
//RESULTS
printf ('density = %.3f lbm/ft^3',w1)
printf ('\n mean flow velocity = %.1f ft/sec',V1)
printf ('\n Match number = %.4f ',Ma1)
printf ('\n Reynolds number = %.2e ',Re)
printf ('\n Length of pipe = %.2e ft',dx)
```

Scilab code Exa 7.9 ex 9

```
clc
//initialisation of variables
clear
r= 1.4
R= 53.3 //ft lbf/lbm R
g= 32.2 //ft/sec^2
T1= 410 //R
v= 2500 //ft/sec
P1= 628 //lbf/in^2
```

```
//CALCULATIONS
v1= sqrt(r*g*R*T1)
Ma1= v/v1
Ts1= T1*(1+0.5*(r-1)*Ma1^2)
Ps1= P1*(1+0.5*(r-1)*Ma1^2)^(r/(r-1))
Ps2= Ps1*((r+1)/(2*r*Ma1^2-r+1))^(1/(r-1))*(0.5*(r
    +1)*Ma1^2/(1+0.5*(r-1)*Ma1^2))^(r/(r-1))
//RESULTS
printf ('acoustic velocity = %.f ft/sec',v1)
printf ('\n Match number = %.2f ',Ma1)
printf ('\n Stagnition temperature = %.f R',Ts1)
printf ('\n Stagnition pressure = %.f lbf/ft^2',Ps1)
printf ('\n Stagnition pressure = %.f lbf/ft^2',Ps2)
```

Scilab code Exa 7.10 ex 10

```
clc
//initialisation of variables
clear
p2= 67.2 //lbf/in^2
p1= 63 //lbf/in62
r= 1.4
n= 0.6
T1= 870 //R
ma1= 0.8 //ft/sec
//CALCULATIONS
dt= (p2/p1)^((r-1)/r)-1
dt1= dt/n
T2= T1*(1+dt1)
Ts1= T1*(1+0.5*(r-1)*ma1^2)
ps1= p1*(1+0.5*(r-1)*ma1^2)^(r/(r-1))
ps2= p2*(Ts1/T2)^(r/(r-1))
dp= ps1-ps2
//RESULTS
 printf ('dT = %.5f ',dt)
```

```
printf ('\n dT1 = %.5f ',dt1)
printf ('\n Temperature = %.f R',T2)
printf ('\n Temperature = %.1f R',Ts1)
printf ('\n Pressure = %.1f lbf/in^2',ps1)
 printf ('\n Pressure = %.1f lbf/in^2',ps2)
  printf ('\n pressure difference = %.1f lbf/in^2',
     dp)
```

Scilab code Exa 7.11 ex 11

```
clc
//initialisation of variables
clear
r= 1.4
ma3= 3 //ft/sec
ps= 80 //lbf/ft^2
Ts= 840 //R
r1= 53.3 //ft lbm/ft^3
A3= 2 //in^2
g= 32.2 //ft/sec^2
ma1= 1.6
//CALCULATIONS
R= (1+(r-1)*0.5*ma3^2)^(r/(r-1))
p3= ps/R
R1= 1+0.5*(r-1)*ma3^2
T3= Ts/R1
w3= p3*144/(r1*T3)
V3= ma3*sqrt(r*r1*g*T3)
m= w3*V3*A3/144
ra= ((r+1)/(2*r*ma1^2-(r-1)))^(1/(r-1))*(0.5*(r+1)*
   ma1^2/(1+0.5*(r-1)*ma1^2))^(r/(r-1))
ps2= ps*ra
dp= ps-ps2
//RESULTS
printf ('outlet pressure = %.2f lbf/in^2',p3)
```

```
printf ('\n outlet temperature = %.f R',T3)
printf ('\n mass flow rate = %.3f lbm/sec',m)
printf ('\n mass flow rate = %.3f lbm/sec',m)
 printf ('\n ps2 = %.1f lbf/in^2',ps2)
 printf ('\n pressure difference = %.1f lbf/in^2',
    dp)
```

Chapter 8

analysis of dimensional constant density laminar flow

Scilab code Exa 8.2 ex 2

```
clc
//initialisation of variables
clear
w= 78.9 //lbf.ft^3
d= 0.01 //in
u= 8.67*10^-9 //lbf/ hr ft^2
h= 18 //ft
l= 10 //ft
//CALCULATIONS
Q= %pi*w*(d/12)^4*(h+l)/(l*128*u)
//RESULTS
printf ('Flow rate = %.2e ft^3/hr',Q)
```

Scilab code Exa 8.3 ex 3

```
clc
```

```
//initialisation of variables
clear
x= 0.1 //ft
w= 62.4 //lbf/ft^3
v1= 10 //ft/sec
u= 2.4*10^-5 //lbf/ft
g= 32.2 //ft/sec^2
k= 4.91
//CALCULATIONS
s= k*x*(w*v1*x/(u*g))^-0.5
Tw= 0.332*w*v1^2*(u*g/(w*x*v1))^0.5/g
R= 0.332*6*Tw
//RESULTS
printf ('Thickness = %.2e*ft',s)
printf ('\n Shear stress = %.3f lbf/ft^2',Tw)
printf ('\n Shear stress = %.3f lbf/ft',R)
```

Scilab code Exa 8.4 ex 4

```
clc
//initialisation of variables
clear
r=1
r1=1
//CALCULATIONS
e1= r+r1
e2= r-r1
//RESULTS
printf ('vorticity = %.f*k',e1)
printf ('\n vorticity = %.f',e2)
```

Chapter 9

analysis of dimensional constant density turbulent flow

Scilab code Exa 9.1 ex 1

```
clc
//initialisation of variables
clear
n=7
w= 62.4 //lbf/ft^3
v= 6 //ft/sec
d= 2 //in
u= 2.34*10^-5 //lbf/ft^3
f= 0.0178
g= 32.2 //ft/sec^2
R= 1.224
R1= 8 //ft/sec
//CALCULATIONS
r= (n+1)*(2*n+1)/(2*n^2)
Red= w*v*(d/12)/(u*g)
C= (d/Red)^(1/7)*R*(R1/f)^(4/7)
V = v*sqrt(f/8)
//RESULTS
printf ('Vmax/V = %.3f',r)
```

```
printf ('\n Red = %.2e',Red)
printf ('\n C = %.2f',C)
printf ('\n Velocity = %.3f ft/sec',V)
```

Scilab code Exa 9.3 ex 3

```
clc
//initialisation of variables
clear
Re= 5
g= 32.2 //ft/sec^2
u= 2.34*10^-5 //lbf/ft sec
w= 62.4 //lbf/ft^3
v= 0.283 //ft/sec
Re1= 70
v1= 0.0374 //ft/sec
//CALCULATIONS
y= Re*u*g/(w*v)
y1= Re1*u*g/(w*v)
y2= Re*u*g/(w*v1)
y3= Re1*u*g/(w*v1)
//RESULTS
printf ('y = %.6f ft',y)
printf ('\n y = %.5f ft',y1)
printf ('\n y = %.5f ft',y2)
printf ('\n y = %.4f ft',y3)
```

Chapter 10

External flows

Scilab code Exa 10.1 ex 1

```
clc
//initialisation of variables
clear
g= 32.2 //ft/sec^2
u= 3.6*10^-5 //lbf sec/ft^2
d= 64 //lbm/ft^2
l= 20 //ft
a= 0.5
//CALCULATIONS
sw= u*g/(a*d)
sw1= u^2*g*l/(2*a*d)
Re=[1 2 3 4 5 6 7 8 9 10]*10^5
Vinf=Re*u*g/(d*a)
Cd=[1.2 1.15 0.94 0.68 0.305 0.31 0.32 0.33 0.34
    0.35]
cdre=Cd.*Re^2
D=sw1*cdre
//RESULTS
printf ('velocity = %.2e ft/sec',sw)
printf ('\n Force = %.2e lbf',sw1)
disp(Vinf)
```

```
disp(D)
```

Scilab code Exa 10.2 ex2

```
clc
//initialisation of variables
clear
g= 32.2 //ft/sec^2
u= 3.6*10^-5 //lbf sec/ft^2
d= 64 //lbm/ft^2
l= 20 //ft
a= 0.5
//CALCULATIONS
sw= u*g/(a*d)
sw1= u^2*g*l/(2*a*d)
Re=[1 2 3 4 5 6 7 8 9 10]*10^5
Vinf=Re*u*g/(d*a)
Cd=[1.2 1.15 0.94 0.68 0.305 0.31 0.32 0.33 0.34
   0.35]
cdre=Cd.*Re^2
D=sw1*cdre
//RESULTS
plot(Vinf,D)
xtitle("","Vinf, ft/sec", "D, lbf")

//data for curves b,c,d is not given
```

Scilab code Exa 10.3 ex 3

```
clc
//initialisation of variables
clear
v1= 10 //ft/sec
```

```
v2= 9 //ft/sec
a= 1.02
r= 5.95
//CALCULATIONS
ca= (v1/v2)^2
Cd= r*(ca-1+2-2*ca)+2*a*ca
//RESULTS
printf ('Drage coeffcieicnt = %.2f',Cd)
```

Scilab code Exa 10.4 ex 4

```
clc
//initialisation of variables
clear
A= 320 //ft/^2
w= 18000 //lbf
v= 230 //ft/sec
ad= 0.0765 //lbm/ft^3
p= 5 //per cent
c= 0.055
n= 1.75
g= 32.2 //ft/sec^2
//CALCULATIONS
CL= 2*w*(1-(p/100))*g/(ad*v^2*A)
D= w*(1-(p/100))*c*n/CL
//RESULTS
printf ('lift coeefieicnt = %.2f',CL)
printf ('\n Drage force = %.f',D)
```

Scilab code Exa 10.5 ex 5

```
clc
//initialisation of variables
```

```
clear
bi= 70 //degrees
i= 8 //degrees
bo= 130 //degrees
s= 5 //degrees
vi= 1200 //ft/sec
g= 32.2 //ft/sec^2
a= 0.48
s1= 1.4 //in
b= 5 //in
Cx= 0.06
//CALCULATIONS
O= bo-s-bi+i
Vo= vi*sind(bi-i)/sind(bo-s)
Fy= -a*vi*sind(bi-i)*(s1/12)*(b/12)*(Vo*cosd(bo-s)-
   vi*cosd(bi-i))/g
dp= a*(Vo^2*(1+Cx)-vi^2)/(2*g)
//RESULTS
printf ('Fluid deflection angle = %.f degrees',O)
printf ('\n Vo = %.f ft/sec',Vo)
printf ('\n Force on each blade = %.f lbf',Fy)
printf ('\n Pressure difference = %.f lbf/ft^2',dp)
```

Scilab code Exa 10.6 ex 6

```
clc
//initialisation of variables
clear
ari= 62 //degrees
aro= 125 //degrees
vri= 1200 //ft/sec
vro= 1294 //ft/sec
vrr= 550 //ft/sec
//CALCULATIONS
v1= vri*sind(ari)
```

```
v2= vrr+vri*cosd(ari)
vi= sqrt(v1^2+v2^2)
ai= atand(v1/v2)
vo= vro*sind(aro)
vo1= vro*cosd(aro)+vrr
vo2= sqrt(vo^2+vo1^2)
ao= atand(vo/vo1)+180
//RESULTS
printf ('absolute velocity = %.f ft/sec',vi)
printf ('\n direction = %.1f degrees',ai)
printf ('\n absolute velocity = %.f ft/sec',vo2)
printf ('\n direction = %.1f degrees',ao)
```

Chapter 11

elementary analysis

Scilab code Exa 11.1 ex 1

```
clc
//initialisation of variables
clear
rt= 1.3 //ft
rr= 0.6 //ft
Q= 75 //ft^3
rm= 0.95
w1= 40 //rev/sec
bim= 153 //degrees
bom= 147 //degrees
w= 62.4 //lb/ft^3
g= 32.2 //ft/sec^2
//CALCULATIONS
A= %pi*(rt^2-rr^2)
Va= Q/A
Vbm= rm*w1
a= acotd(-Vbm/Va)
im= a-bim
vwm= Vbm+Va*cotd(bom)
dvwm= rm*vwm
C= w*Q*dvwm/g
```

```
Cw= C*w1
dp= Cw/Q
//RESULTS
printf ('Incidence = %.1f degrees',im)
printf ('\n Oulet velocity = %.2f ft/sec',vwm)
printf ('\n Change of whirl at the mean radius = %.2
   f ft^2/sec',dvwm)

printf ('\n Torque = %.f lbf/ft',C)
printf ('\n Rate of working = %.f ft lbf/sec',Cw)
printf ('\n Workdone by the rotor = %.f lbf/ft^2',dp
   )
```

Scilab code Exa 11.2 ex 2

```
clc
//initialisation of variables
clear
vbm= 38 //ft/sec
va= 17.94 //ft/sec
a= 147.5 //degrees
vwm= 10.37 //ft/sec
C= 1430 //lbf/ft
P= 763 //lbf/ft^2
//CALCULATIONS
vwm1= vbm+va*cotd(a)
p= (vwm-vwm1)/vwm
C1= C*(1-p)
P1= P*(1-p)
//RESULTS
printf ('Oulet Velocity = %.2f ft/sec',vwm1)
printf ('\n Torque = %.f lbf/ft',C1)
printf ('\n Workdone by the rotor = %.f lbf/ft^2',P1
   )
```

Scilab code Exa 11.3 ex 3

```
clc
//initialisation of variables
clear
a= 154 //degrees
vbm= 38 //ft/sec
bom= 147 //degrees
vwm= -7.78 //ft/sec
w= 62.4 //lbf/ft^3
g= 32.2 //ft/sec^2
vb= 38 //ft/sec
A= 4.18 //ft^2
e= 0.95
//CALCULATIONS
vat= (vwm-vb)*tand(bom)
Q= vat*A
a1= acotd(-vbm/vat)
imt= a1-a
C= w*Q*vwm*e/g
//RESULTS
printf ('Flow rate = %.1f ft^3',Q)
printf ('\n Incidence angle= %.f degrees',imt)
printf ('\n Torque= %.f lbf ft',C)
```

Scilab code Exa 11.4 ex 4

```
clc
//initialisation of variables
clear
rt= 0.5 //ft
rr= 0.16 //ft
```

```
dv1= 88.3 //ft/sec
b= 150 //degrees
r= [0.16 0.3 0.5]
vw= [2.5 5 7.5]
vb= [46.6 88.3 132.5]
vrb= [44.16 88.3 132.5]
v1= [-1.154 -0.385]
//CALCULATIONS
A= %pi*(rt^2-rr^2)
Va= -dv1*tand(b)
Q= Va*A
a= atand(v1)+180
i= b-a
//RESULTS
printf ('Velocity = %.2f ft/sec',Va)
printf ('\n Flow rate = %.1f ft^3',Q)
disp(v1)
disp(a)
disp(i)
```

Scilab code Exa 11.5 ex 5

```
clc
//initialisation of variables
clear
rt= 0.5 //ft
rr= 0.16 //ft
dv1= 88.3 //ft/sec
b= 150 //degrees
a= 5 //degrees
v1= [-0.933 -0.311]
i= [1.0 5.0 6.7]
//CALCULATIONS
b1= b+a
A= %pi*(rt^2-rr^2)
```

```
Va= -dv1*tand(b1)
Q= Va*A
a1= atand(v1)+180

//RESULTS
printf ('Velocity = %.2f ft/sec',Va)
printf ('\n Flow rate = %.1f ft^3/sec',Q)

disp(v1)
disp(a1)
disp(i)
```

Scilab code Exa 11.6 ex 6

```
clc
//initialisation of variables
clear
r= 1 //in
b= 0.75 //in
w= 180 //rev/sec
B= 120 //degrees
Bo= 150 //degrees
ro= 3 //ft
bo= 0.5 //ft
Vbo= 180 //ft/sec
w1= 62.4 //lbf/ft^3
g= 32.2 //ft/sec^2
//CALCULATIONS
Q= -2*%pi*(r/12)^2*(b/12)*w*tand(B)
Vfo= Q/(2*%pi*(ro/12)*(bo/12))
Vwo= Vbo*(ro/12)+Vfo*cotd(Bo)
C= w1*Q*Vwo*(ro/12)/g
dp= w1*Vwo*w*(ro/12)/g
ari= atand(-Q*0.8/(2*%pi*(r/12)^2*(b/12)*w))+180
i1= ari-B
```

```
//RESULTS
printf ('Flow rate = %.2f ft^3/sec',Q)
printf ('\n radial velocity= %.2f ft/sec',Vfo)
printf ('\n outlet whirl velocity= %.2f ft/sec',Vwo)
printf ('\n Torque= %.2f lbf ft',C)
printf ('\n Stagnant pressure = %.f lbf/ft^2',dp)
printf ('\n Incidence angle = %.1f degrees',i1)
```

Scilab code Exa 11.7 ex 7

```
clc
//initialisation of variables
clear
r= 1.4
Mai= 0.5 //ft/sec
T= 582 //R
psi= 3040 //lbf/in^2
R= 53.3 //ft lbf/lbm
g= 32.2 //ft/sec^2
Vwi= 300 //ft/sec
m= 35 //lb/sec
rm= 0.7 //ft
rp= 4.25
w= 1200 //rev/sec
cp= 0.24
J= 778 //lb
//CALCULATIONS
tr= 1+0.5*(r-1)*Mai^2
Ti= T/tr
pr= tr^(r/(r-1))
pi= psi/pr
ai= pi/(R*Ti)
Vi= Mai*(r*R*g*Ti)^0.5
Vai= sqrt(Vi^2-Vwi^2)
h= m/(2*%pi*ai*rm*Vai)
```

```
pr1= rp^(1/12)
Vwo= Vwi+(pr1^((r-1)/r)-1)*(cp*J*g*T/(rm*w))
BO= acotd((Vwo-w*rm)/Vai)
//RESULTS
printf ('Absolute air velocity = %.f ft/sec',Vi)
printf ('\n air velocity = %.f ft/sec',Vai)
printf ('\n Blade height = %.3f ft',h)
printf ('\n velocity = %.f ft/sec',Vwo)
printf ('\n outlet balde angle = %.1f degrees',BO)
```

Chapter 12

TURBOMACHINES

Scilab code Exa 12.1 ex 1

```
clc
//initialisation of variables
clear
d= 0.0764 //lbm/ft^3
u= 3.74*10^-7 //lbf sec/ft^2
D= 15 //in
g= 32.2 //ft/sec^2
p= 14.7 //lb/in^2
r1= [0.02 0.04 0.06 0.08 0.1 1.15]
r2= [0.0338 0.0267 0.0199 0.0159 0.0132 0.0100]
r3= [0.46 0.92 1.38 1.84 2.3 2.64]
r4= [2.97 2.35 1.75 1.4 1.16 0.88]
r5= [0.0206 0.0163 0.0121 0.0097 0.0081 0.0061]
//CALCULATIONS
re= (d/u)*(p*100*2*%pi/60)*(D/12)^2/g
//RESULTS
printf ('Reynolds Number = %.2e ',re)
xtitle("","m lbm/sec", "dPs lbf/ft^2")

disp(r1)
disp(r2)
```

```
disp(r3)
disp(r4)
disp(r5)
plot(r3,r5)
```

Scilab code Exa 12.2 ex 2

```
clc
//initialisation of variables
clear
psif= 10.2 //lbf/in^2
usit= 3.8*10^-7 //lbf sec/ft^2
usif= 3.52*10^-7 //lbf sec/ft^2
Tsit= 530 //R
Tsif= 480 //R
wf= 15000 //rev/min
//CALCULATIONS
Psit= psif*usit*sqrt(Tsit/Tsif)/usif
wt= wf*sqrt(Tsit/Tsif)
//RESULTS
printf ('Pressure in the test cell = %.1f lbf/in^2',
   Psit)
printf ('\n Compressor speed = %.f rev.min',wt)
```

Scilab code Exa 12.3 ex 3

```
clc
//initialisation of variables
clear
w= 62.3 //lbf/ft^3
d= 0.375 //in
ro= 0.75 //ft
l= 1.25 //ft
```

```
b= 120 //degrees
do= 0.25 //in
p= 750 //lbf/in^2
g= 32.1 //ft/sec^2
f= 0.03
f1= 0.9
f2= 0.3
w1= 60 //rad/sec
//CALCULATIONS
Q= sqrt(((p/w)+((60*ro)^2/(2*g))+do)*%pi^2*g*(d/12)
    ^4/((d/do)^4-1+(l*f/(d/12))+f1+f2))*0.353
Vwo= w1*ro+(4*Q/(%pi*(do/12)^2))*cosd(b)
C= w*Q*Vwo*ro/g
//RESULTS
printf ('Flow Rate = %.4f ft^3/sec',Q)
printf ('\n Vwo = %.2f ft/sec',Vwo)
printf ('\n Driving Torque = %.3f lbf ft',C)
```

Scilab code Exa 12.4 ex 4

```
clc
//initialisation of variables
clear
W= 38 //rev/sec
w= 62.4 //lbf/ft^3
m= 2000 //lbm/sec
g= 32.2 //ft/sec^2
ps= 5000 //lbf/ft^2
S3= 4.6
e= 0.91
//CALCULATIONS
S1= W*(w*m^2/(g*ps)^3)^0.25
D= S3*(m^2/(w*g*ps))^0.25
//RESULTS
printf ('S1 = %.3f',S1)
```

```
printf ('\n Diameter = %.2f ft',D)
printf ('\n efficiency = %.2f ',e)
```

Scilab code Exa 12.5 ex 5

```
clc
//initialisation of variables
clear
d= 6 //in
f= 0.25
l= 1200 //ft
p= 55 //lbm/ft^3
w= 740 //rev/min
g= 32.2 //ft/sec^2
n= 0.87
d1= 1.78 //ft
//CALCULATIONS
D= (0.13*%pi^2*(d/12)^5/(8*f*l*0.012^2))^0.25*d1
m= 0.012*p*(w*2*%pi/60)*D^3
dps= 0.13*p*(w*2*%pi*D/60)^2/g
P= m*10*dps/(p*n)
//RESULTS
printf ('Diameter = %.2f ft',D)
printf ('\n Mass flow rate = %.1f lbm/sec',m)
printf ('\n pressure rise = %.1f lbf/ft^2',dps)
printf ('\n shaft power = %.2e ft lbf/sec',P)
```

Chapter 13

Hydraulic power transmission

Scilab code Exa 13.1 ex 1

```
clc
//initialisation of variables
clear
nop= 0.88
nom= 0.88
Pm= 75 //hp
p= 3000 //lb/in^2
d= 54.5 //lbm/ft^3
u= 1.05*10^-4
d1= 0.5 //in
g= 32.2 //ft/sec^2
//CALCULATIONS
nt= (7/11)*nop*nom
pp= Pm/nt
Q= nop*pp*550/(p*144)
Re= 4*d*Q/(%pi*u*(d1/12)*g)
//RESULTS
printf ('n trans = %.3f ',nt)
printf ('\n Input power = %.f hp',pp)
printf ('\n Flow rate = %.3f ft^3/sec',Q)
printf ('\n Reynolds Number = %.1e ',Re)
```

Scilab code Exa 13.2 ex 2

```
clc
//initialisation of variables
clear
lc= 0.25
a= 90 //degrees
p= 3000 //lb/in^2
g= 32.2 //ft/sec^2
d1= 0.5 //in
Q= 0.171 //ft^3/sec
d= 54.5 //lbm/ft^3
n1= 2
n2= 6
lc1= 0.9
nop= 0.88
nom= 0.88
//CALCULATIONS
P1= 4*p*144/11
P2= 8*d*Q^2*(n1*lc+n2*lc1)/(%pi^2*(d1/12)^4*g)
pt= P1+P2
dpm= (p*144-pt)
ntrans= nop*nom*dpm/(p*144)
//RESULTS
printf ('Frictional pressure drop = %.2e lbf/ft^2',
    P1)
printf ('\n Extra Frictional pressure drop = %.2e
    lbf/ft^2',P2)
printf ('\n Total pressure drop = %.2e lbf/ft^2',pt)
printf ('\n Motor pressure drop = %.2e lbf/ft^2',dpm
    )
printf ('\n Overall transmission coefficiency = %.3f
    ',ntrans)
```

Scilab code Exa 13.3 ex 3

```
clc
//initialisation of variables
clear
bip= 135 //degrees
bop= 150 //degrees
bot= 140 //degrees
bos= 137 //degrees
r= 1.8
r1= 1.8
r2= 0.7
r3= 0.95
//CALCULATIONS
R= (1+(cotd(bip)/cotd(bos)))*r^2-r1*(cotd(bop)/cotd(
    bos))
R1= r2*r3^2*(1+(cotd(bip)/cotd(bos)))-(cotd(bot)/
    cotd(bos))
R2= (R1-R)/(R-1)
//RESULTS
printf ('R1 = %.2f',R)
printf ('\n R2 = %.2f',R1)
printf ('\n Torque ratio = %.2f',R2)
```

Chapter 14

Further Devolopments

Scilab code Exa 14.1 ex 1

```
clc
//initialisation of variables
clear
a= 60.5
Q= 0.2 //ft^3/sec
d= 3 //in
u= 0.0325
g= 32.2 //ft/sec^2
T= [50.0 60.0 70.0 80.0 90.0 100.0]
Ep= [294.5 188.6 113.2 60.4 37.7 24.5]
Eh= [0 69.9 139.8 209.7 279.5 349.4]
Et= [295 258 253 270 317 374]
//CALCULATIONS
re= a*4*Q/(%pi*(d/12)*u*g)
//RESULTS
printf ('Reynolds Number = %.1f ',re)
disp(T)
disp(Ep)
disp(Eh)
disp(Et)
plot(T,Ep)
```

```
plot(T,Eh)
plot(T,Et)

xtitle("","T (F)", "Eh,Ep,Eh&Ep (kW)")
```

Scilab code Exa 14.2 ex 2

```
clc
//initialisation of variables
clear
wcb= 2 //ton
wc= 100 //ton
wa= 6.5 //ton
wca= 20
r= 0.8
r1= 1.2
//CALCULATIONS
wca1= wc/wa
wca2= wcb*(wca1/wca)^1.5
Wca= wcb*r^(9/4)*(1/r1)^(9/4)*(wca1/wca)^1.5
//RESULTS
printf ('(Wc/W)a = %.2f ',wca1)
printf ('\n Wc,a = %.2f ton',wca2)
printf ('\n Wc,a = %.2f ton',Wca)
```