

Scilab Textbook Companion for
Fluid Mechanics
by I. A. Khan¹

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

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Book Description

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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

Fluid Properties

Scilab code Exa 1.1 properties of fluid

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

Scilab code Exa 1.2 fluid properties

```
1 //example1.2
2 //page 12
3 clc; funcprot(0);
4 //initialisation of variable
5 delP=10^6;//change in pressure
```

```

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

```

Scilab code Exa 1.3 change in volume

```

1 //example 1.3
2 //page 13
3 clc; funcprot(0);
4 //initialisation of variable
5 Beta1=2.28*10^9;
6 Beta2=2.94*10^9;
7 Beta_av=Beta1/2+Beta2/2;
8 delP=1034-103.4;
9 V=10;
10 delV=-delP/Beta_av*V;
11 disp(-delV,"net reduction of volume(m^3)=");
12 clear

```

Scilab code Exa 1.4 change in volume

```

1 //example 1.4
2 //page 14
3 clc; funcprot(0);
4 //initialisation of variable
5 delP=102-100;
6 Beta1=102+14.6;
7 Beta2=100+14.6;
8 Beta_av=Beta1/2+Beta2/2;
9 V=1;

```

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

Scilab code Exa 1.5 viscosity

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

Scilab code Exa 1.6 force on fluid

```
1 //example 1.6
2 //page 20
3 clc; funcprot(0);
4 //initialisation of variable
5 mu=0.09//viscosity
6 U=1;//velocity
7 Y=1/1000;//clearence
8 L=0.2;
9 d=0.05;
10 pi=3.14;
11 sigma=mu*U/Y;//stress
12 A=pi*d*L;
13 F=A*sigma;
14 disp(F,"Force applied (N)=");
```


15 `clear`

Scilab code Exa 1.7 force on fluid

```
1 //example 1.7
2 //page 21
3 clc; funcprot(0);
4 //initialisation of variable
5 //part1
6 y=poly([0 0.01 -1], 'x', 'coeff');
7 z=roots(y);
8 disp(z(1), "distance between walls (m)");
9 //part2
10 mu=1.005/1000; //viscosity
11 sigma=-mu*10*(0.01-2*z(1));
12 disp(sigma, "shear stress on the wall(N/m^2)=");
13 //part3
14 y=20*10^-6;
15 sigma=mu*10*(0.01-2*y);
16 disp(sigma, "shear stress on the wall(N/m^2)=");
17 //part4
18 y=0.01/2;
19 disp(y, "distance at which stress becomes zero(m)=");
20 //part5
21 y=0.01/2;
22 disp(y, "distance at which velocity is maximum(m)=");
23 clear
```

Scilab code Exa 1.8 torque

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

```

4 //initialisation of variable
5 R1=0.05;//radius 1
6 R2=0.05+0.00002;//radius 2
7 L=0.2;
8 N=30/60;//omega
9 t=R2-R1;
10 pi=3.14;
11 mu=0.44;//viscosity
12 //part1
13 U=pi*N*0.1;
14 T=R1^2*2*pi*U/t*mu*L;//torque
15 disp(T,"torque applied (Nm)");
16 //part2
17 T=R1*2*pi*mu*L*U/log(R2/R1);
18 disp(T,"torque applied (Nm)");
19 clear

```

Scilab code Exa 1.9 power required

```

1
2
3
4 //example 1.9
5 //page 27
6 clc; funcprot(0);
7 //initialisation of variable
8 mu=0.44;
9 N=300;
10 t=0.00025;//thickness
11 R1=0.15;//radius
12 R2=0.1;//radius
13 pi=3.14;
14 T=pi^2*mu*N/60/t*(R1^4-R2^4);
15 P=T*2*pi*N/60
16 disp(P,"power lost in (watts)");

```

17 `clear`

Scilab code Exa 1.10 surface tension

```
1
2 //example 1.10
3 //page 29
4 clc; funcprot(0);
5 //initialisation of variable
6 d=0.01; //diameter
7 sigma=0.073; //from table
8 delP=4*sigma/d;
9 disp(delP, "excess pressure in (N/m^2)");
10 clear
```

Scilab code Exa 1.11 capillary

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

Chapter 2

Fluid Statics

Scilab code Exa 2.1 force on piston

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

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

```
1 //example 2.2
2 //page 53
3 clc; funcprot(0);
4 //initialisation of variable
```

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

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

```
1 //example 2.3
2 //page 53
3 clc; funcprot(0);
4 //initialisation of variable
5 Gamma=9.81;
6 S=0.85;//specific gravity
7 P1=150;
8 h1=0.8;//height
9 h2=2;
10 P2=P1+Gamma*S*h1;
11 P3=P2+Gamma*h2;
12 disp(P3,"pressure at the bottom (kN/m^2)");
13 clear
```

Scilab code Exa 2.4 height of the mountain

```
1 //example 2.4
2 //page 54
3 clc; funcprot(0);
4 //initialisation of variable
5 P0=570;
6 P1=750;
7 R=287;
8 T0=-5+273;//temperature
9 n=1.2345;
```

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

Scilab code Exa 2.5 pressure

```
1
2 //example 2.5
3 //page 57
4 clc; funcprot(0);
5 //initialisation of variable
6 Gamma=9810;
7 ha=950*1.5-500*1;
8 ha=ha/1000; //m of H2O;
9 Pa=ha*Gamma;
10 disp(Pa/1000,"Pressure at A (kPa)=");
11 clear
```

Scilab code Exa 2.6 force required to open the gate

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

```

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

```

Scilab code Exa 2.7 depth of center of pressure

```

1 //example 2.7
2 //page 67
3 clc; funcprot(0);
4 //initialisation of variable
5 A=2;
6 pi=3.14;
7 Gamma=9810;
8 theta=pi/3;
9 ybar=0.75+sin(pi/3);
10 Ig=2^3/12; //moment of inertia
11 //part1
12 F=Gamma*A*ybar; //force
13 disp(F,"Total Force (N)=");
14 //part2
15 hbar=ybar+Ig*(sin(theta))^2/A/ybar; //centroid
16 disp(hbar,"depth of center of pressure(m)=");
17 clear

```

Scilab code Exa 2.8 depth of hydrostatic pressure

```

1 //example 2.8
2 //page 68
3 clc; funcprot(0);
4 //initialisation of variable
5 pi=3.14;
6 theta=pi/6;

```

```

7 Gamma=9810;
8 d=6; //diameter
9 A=pi*d^2/4; //area
10 Ig=pi*d^4/64;
11 Pdash=600; //pressure
12 Fdash=Pdash*A;
13 ybar=10+2+3*sin(theta);
14 F=Gamma*A*ybar; //force
15 hbar=ybar+Ig*(sin(theta))^2/A/ybar; //centroid
16 Hbar=(F*hbar+Fdash*ybar)/(F+Fdash);
17 disp(Hbar,"depth of hydrostatic pressure(ft)=");
18 clear

```

Scilab code Exa 2.10 hydrostatic force

```

1 //example 2.10
2 //page 75
3 clc; funcprot(0);
4 //initialisation of variable
5 ybar=4;
6 pi=3.14;
7 A=4;
8 Gamma=62.4;
9 Ig=4^3/12;
10 x1=2;
11 x2=1.7;
12 hbar=ybar+Ig/A/ybar;
13 Fv1=2*A*Gamma;
14 Fv2=pi*A*Gamma;
15 Fv=Fv1+Fv2;
16 disp(Fv,"vertical component of Hydrostatic force(lbs
    )=");
17 xv=(Fv1*x1+Fv2*x2)/(Fv1+Fv2);
18 disp(xv,"point of application of vertical force(ft)"
    );

```


19 `clear`

Scilab code Exa 2.11 hydrastatic Force

```
1 //example 2.11
2 //page 77
3 clc; funcprot(0);
4 //initialisation of variable
5 pi=3.14;
6 P=50*144; //pressure
7 Gamma=62.4; //unit weight
8 A=4*1; //area
9 Ig=4^3/12;
10 ybar=115.4+2.5+2;
11 //part1
12 Fh=Gamma*A*ybar;
13 disp(Fh,"Horizontal component of Hydrastatic Force(
   lbs)=");
14 //part2
15 hbar=ybar+Ig/A/ybar;
16 Fv1=Gamma*A*117.9;
17 Fv2=pi*4^2/4*Gamma;
18 Fv=Fv1+Fv2;
19 disp(Fv,"Vertical component of Hydrostatic force (
   lbs)=");
20 xv=(Fv1*2+Fv2*1.7)/Fv;
21 disp(xv,"point of application of vertical force(ft)"
   );
22 clear
```

Scilab code Exa 2.13 depth submerged

```
1 //example 2.13
```

```

2 //page 84
3 clc; funcprot(0);
4 //initialisation of variable
5 GammaB=9810*0.9;//unit weight barrage
6 Gamma=9.81*1.09*1000;//unit weight of liquid
7 Area=15*4;
8 Volume=3*Area;
9 AW=150*1000;//additional weight
10 W=GammaB*Volume;
11 TW=AW+W;//total weight
12 depth=TW/Gamma/Area;
13 disp(depth,"depth submerged (m)=");
14 clear

```

Scilab code Exa 2.14 bottom of solid cylinder above ground

```

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

```

Scilab code Exa 2.15 riding Moment

```
1
2 //example 2.15
3 //page 86
4 clc; funcprot(0);
5 //initialisation of variable
6 Gamma=9810;
7 x1=20/100/3;
8 x2=20/2/100;
9 theta=atan(4/20);
10 V=4*20*100/100^3/2; //volume
11 Fb=Gamma*V; //Force Buoyant
12 W=Fb-1.5; //total weight
13 x=(x2-x1)*cos(theta);
14 M=W*x;
15 disp(M*100,"Riding Moment (Ncm)=");
16 clear
```

Scilab code Exa 2.16 metacentric height

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

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

Scilab code Exa 2.17 maximum value

```
1 //example 2.17
2 //page 90
3 clc; funcprot(0);
4 //initialisation of variable
5 pi=3.14;
6 ax=2.6;
7 ay=1.5;
8 g=9.81;
9 m=-ax/(ay+g);
10 //y2=y1-m*6; putting this value in second equation
11 y1=0.81;
12 y2=2.19;
13 x=linspace(0,15,15);
14 y=-11310*-y2-2600*x;
15 clf()
16 plot(y,x);
17 //from the graph maximum occurs when
18 x=0;
19 disp(x,"maximum occurs at that value");
20 clear
```

Scilab code Exa 2.18 pressure in pound per feet square

```
1 //example 2.18
2 //page 90
3 clc; funcprot(0);
4 pi=3.14;
```

```
5 y0=1;
6 g=32.2;
7 r0=0.5; // radius
8 Gamma=62.4;
9 omega=2*pi*150/60;
10 //part1
11 h0=y0+omega^2*r0^2/4/g;
12 disp(h0,"height of paraboloid(ft)=");
13 //part2
14 Pmax=Gamma*h0;
15 disp(Pmax,"maximum pressure(lbs/ft^2)=");
16 //part3
17 z=y0-omega^2*r0^2/4/g;
18 r=0.2;
19 y=-0.27;
20 P=Gamma*omega^2/2/g*r^2-Gamma*y;
21 disp(P,"Pressure(lbs/ft^2)=");
22 clear
```

Chapter 3

Fluid Kinematics

Scilab code Exa 3.1 mass flow rate

```
1
2
3 //example 3.1
4 //page 119
5 clc; funcprot(0);
6 // Initialization of Variable
7 rho=997.1;
8 pi=3.14;
9 v=15; //velocity
10 A=pi*0.3^2/4;
11 Q=v*A;
12 disp(Q,"discharge in (m^3/s)");
13 m=rho*Q;
14 disp(m,"mass flow rate(kg/s)=");
15 clear
```

Scilab code Exa 3.3 pipe velocity

```

1
2 //example 3.3
3 //page 120
4 clc; funcprot(0);
5 // Initialization of Variable
6 pi=3.14;
7 Q=integrate('10*r-1000*r^3','r',0,0.1);
8 V=2*Q/0.1^2;
9 disp(V,"velocity (m/s)=");
10 clear

```

Scilab code Exa 3.5 streamline

```

1
2 //example 3.5
3 //page 127
4 clc; funcprot(0);
5 // Initialization of Variable
6 x=2;
7 y=4;
8 pi=3.14;
9 u=4*x;//velocity x
10 v=-4*y;//velocity y
11 V=sqrt(u^2+v^2);
12 theta=180/pi*atan(v/u);
13 disp(V,"velocity at (2,4) is (m/s)=");
14 disp(theta,"angle of the velocity with X axis(
    degrees)=");
15 clear

```

Scilab code Exa 3.6 fluid acceleration

```

1

```

```

2 //example 3.6
3 //page 130
4 clc; funcprot(0);
5 // Initialization of Variable
6 pi=3.14;
7 rho=1000;
8 m=25;
9 A1=pi*9^2/4;//area left
10 Ar=pi*2.5^2/4;//area right
11 //part1
12 AA=A1-(A1-Ar)/4;
13 V=m*10^4/rho/AA;
14 disp(V,"velocity at the section AA(m/s)");
15 //part2
16 X=0.1;
17 k=367/(63.62-1.468*X)^2;//k=dV/dX
18 Acx=V*k;
19 disp(Acx,"convective acceleration(m/s^2)");
20 clear

```

Scilab code Exa 3.7 rotational flow

```

1
2 //example 3.7
3 //page 142
4 clc; funcprot(0);
5 // Initialization of Variable
6 //solved for a general value
7 x=1;
8 y=1;
9 k1=-2*sin(y)//dv/dx
10 k2=-x^2*sin(y)//du/dy;
11 R=k1-k2;
12 if R~=0 then
13 disp("flow is rotational");

```


14 end

Scilab code Exa 3.8 rotational flow

```
1
2 //example 3.8
3 //page 143
4 clc; funcprot(0);
5 // Initialization of Variable
6 k1=-9//dv/dx;
7 k2=16//du/dy
8 R=k1-k2;
9 if R~=0 then
10 disp("flow is rotational");
11 end
```

Scilab code Exa 3.9 continuity

```
1
2 //example 3.9
3 //page 147
4 clc; funcprot(0);
5 // Initialization of Variable
6 //solved for sample values
7 x=1;
8 k1=2*x;//du/dx;
9 k2=2*x//dv/dy
10 k3=-4*x//dw/dz
11 R=k1+k2+k3;
12 if R==0 then
13 disp("flow satisfies continuity");
14 end
15 clear
```

Scilab code Exa 3.10 continuity

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

Chapter 4

Fluid Dynamics

Scilab code Exa 4.1 pressure difference

```
1
2 //example 4.1
3 //page 160
4 clc; funcprot(0);
5 // Initialization of Variable
6 Q=0.1;
7 A2=19.63/10000;
8 A1=78.54/10000;
9 z1=6;
10 z2=0;
11 g=9.81
12 Gamma=9810; //specific weight
13 V1=Q/A1;
14 V2=Q/A2;
15 Pdef=Gamma*(V2^2/2/g+z2-z1-V1^2/2/g);
16 disp(Pdef/1000,"pressure difference between 1 and 2
    (kN/m^2)");
17 clear
```

Scilab code Exa 4.2 flow rate in litres per second

```
1
2 //example 4.2
3 //page 161
4 clc; funcprot(0);
5 // Initialization of Variable
6 h=2;
7 d=2.5/100;
8 g=9.81;
9 pi=3.14;
10 Cd=0.65; //coeff of discharge
11 A=pi*d^2/4;
12 Q=Cd*A*sqrt(2*g*h);
13 disp(Q*1000,"flow rate (l/s)=");
14 clear
```

Scilab code Exa 4.3 flow rate in meter cube per second

```
1
2 //example 4.3
3 //page 162
4 clc; funcprot(0);
5 // Initialization of Variable
6 h1=3; //height
7 h2=4; //height
8 b=0.5; //breadth
9 Cd=0.65
10 g=9.81;
11 Q=Cd*2/3*b*sqrt(2*g)*(h2^1.5-h1^1.5);
12 disp(Q,"flow rate (m^3/s)=");
13 clear
```

Scilab code Exa 4.4 flow rate in meter cube per second

```
1
2 //example 4.4
3 //page 164
4 clc; funcprot(0);
5 // Initialization of Variable
6 Cd=0.6;
7 h1=2; //height
8 h2=2.2; //height
9 b=1; //breadth
10 g=9.81;
11 Q2=Cd*2/3*b*sqrt(2*g)*(h2^1.5-h1^1.5);
12
13 A=1*0.3; //area
14 H=2.2;
15 Q1=Cd*sqrt(2*g*H)*A;
16 Q=Q1+Q2;
17 disp(Q,"flow rate (m^3/s)=");
18 clear
```

Scilab code Exa 4.5 flow rate in meter cube per second

```
1
2 //example 4.5
3 //page 165
4 clc; funcprot(0);
5 // Initialization of Variable
6 //on solving  $A_1V_1=A_2V_2$ 
7  $k=0.25 //V_1/V_2$ 
8 pi=3.14;
9 Cd=0.95;
10 d=0.02; //diameter
11 //using bernaulli equation between these points
12  $V_2= \text{sqrt}(2.1582/(1-k^2))$ ;
```

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

Scilab code Exa 4.6 velocity in feet per second

```
1
2 //example 4.6
3 //page 166
4 clc; funcprot(0);
5 // Initialization of Variable
6 g=32.2;
7 delx=0.5;
8 V=sqrt(2*g*delx);
9 disp(V," velocity (ft/s)=" );
10 clear
```

Scilab code Exa 4.7 flow rate in litres per second

```
1
2 //example 4.7
3 //page 173
4 clc; funcprot(0);
5 // Initialization of Variable
6 g=9.81
7 d=0.15;
8 pi=3.14;
9 //on solving bernaulli equation
10 V2=sqrt(2*g*25/4.25);
11 A=pi*d^2/4;
12 Q=A*V2;
13 disp(Q*1000,"flow rate (l/s)=" );
14 clear
```

Scilab code Exa 4.8 power input in kiloWatts

```
1
2 //example 4.8
3 //page 174
4 clc; funcprot(0);
5 //initialisation of variable
6 d1=2/100;
7 d2=6/100;
8 pi=3.14;
9 g=9.81;
10 V2=40;
11 effi=0.8;
12 V1=V2*d1^2/d2^2;
13 A1=pi*d1^2/4; //area
14 A2=pi*d2^2/4; //area
15 Gamma=9810;
16 P1=-50;
17 z2=100;
18 hs=V2^2/2/g-V1^2/2/g-P1/Gamma+z2+30;
19 Q=A1*V1;
20 P=Gamma*Q*hs;
21 Pi=P/effi;
22 disp(Pi/100,"Power input (kW):");
23 clear
```

Scilab code Exa 4.9 pressure head

```
1
2 //example 4.9
3 //page 177
```

```
4 clc; funcprot(0);
5 //initialisation of variable
6 za=500;
7 z1=480;
8 v1=4.08;
9 g=9.81;
10 d=0.25;
11 l1=100; //length
12 //part1
13 k=za-z1-v1^2/2/g-0.02*l1/d*v1^2/2/g; //k=pa/gamma
14 HGLa=z1+k;
15 disp(HGLa,"pressure head at A (m)=");
16 //part2
17 zb=550;
18 v2=0;
19 l2=500;
20 hs=zb-za+0.02*l2/d*v1^2/2/g;
21 HGLb=HGLa+hs;
22 disp(HGLb,"pressure head at B (m)=");
23 clear
```

Chapter 5

Fluid Momentum

Scilab code Exa 5.1 resultant force

```
1
2
3 //example 5.1
4 //page 192
5 clc; funcprot(0);
6 //initialisation of variable
7 Q=0.3;//flow rate
8 D1=0.3;
9 D2=0.15;
10 pi=3.14;
11 rho=1000;
12 P1=175;
13 P2=160;
14 A1=pi*D1^2/4;
15 A2=pi*D2^2/4;
16 V1=Q/A1;
17 V2=Q/A2;
18 theta=45/180*pi;
19 F1=P1*A1*1000;
20 F2=P2*A2*1000;
21 Rx=F1-F2*cos(theta)-rho*Q*(V2*cos(theta)-V1);
```

```

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

```

Scilab code Exa 5.2 resultant force on vane

```

1
2
3 //example 5.2
4 //page 194
5 clc; funcprot(0);
6 //initialisation of variable
7 rho=1.94;
8 V1=80;
9 g=32.2;
10 Q=8;
11 z2=3; //elevation
12 pi=3.14;
13 theta=60/180*pi;
14 V2=sqroot(2*g*(V1^2/2/g-3));
15 Rx=rho*Q*(V1-V2*cos(theta));
16 Ry=rho*Q*(V2*sin(theta));
17 R=sqroot(Rx^2+Ry^2);
18 disp(R,"resultant force on vane (lbs)");
19 th=atan(Ry/Rx);
20 disp(th*180/pi,"angle at which force is applying")
21 clear

```

Scilab code Exa 5.3 resultant force

```

1
2 //example 5.3
3 //page 194
4 clc; funcprot(0);
5 //initialisation of variable
6 Q1=0.5; //flow
7 Q2=0.3; //flow
8 Q3=0.2; //flow
9 D1=0.45; //diameter
10 D2=0.3; //diameter
11 D3=0.15; //diameter
12 pi=3.14;
13 g=9.81;
14 P1=60000; //pressure
15 th1=30/180*pi; //theta1
16 th2=20/180*pi //theta2
17 Gamma=9810;
18 A1=pi*D1^2/4;
19 A2=pi*D2^2/4;
20 A3=pi*D3^2/4;
21 V1=Q1/A1;
22 V2=Q2/A2;
23 V3=Q3/A3;
24 P2=P1+V1^2/2/g*Gamma-V2^2/2/g*Gamma;
25 P3=P1+V1^2/2/g*Gamma-V3^2/2/g*Gamma;
26 F1=P1*A1;
27 F2=P2*A2;
28 F3=P3*A3;
29 Rx=F3*cos(th2)-F2*cos(th1)+1000*(Q2*V2*cos(th1)-Q3*
    V3*cos(th2));
30 Ry=F3*sin(th2)-F2*sin(th1)+1000*(Q2*V2*sin(th1)+Q3*
    V3*sin(th2)-Q1*V1)-F1;
31 R=sqrt(Rx^2+Ry^2);
32 disp(R,"resultant force(N)");
33 clear

```

Scilab code Exa 5.4 impulse of force

```
1
2
3 //example 5.4
4 //page 199
5 clc; funcprot(0);
6 //initialisation of variable
7 D=2;
8 pi=3.14;
9 V=100;
10 A=pi*D^2/4/144;
11 Q=A*V;
12 Rx=62.4/32.2*Q*V;
13 disp(Rx,"impulse of force (lbs)");
14 clear
```

Scilab code Exa 5.5 efficiency

```
1
2 //example 5.5
3 //page 202
4 clc; funcprot(0);
5 //initialisation of variable
6 D=7.5/100;
7 pi=3.14;
8 Vp=10; //velocity plate
9 Gamma=9810;
10 g=9.81;
11 V=15;
12 A=pi*D^2/4;
13 Q=A*V;
```

```

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

```

Scilab code Exa 5.6 resultant reaction

```

1
2 //example 5.6
3 //page 202
4 clc; funcprot(0);
5 //initialisation of variable
6 D=3;
7 pi=3.14;
8 Q=2;
9 rho=1.94;
10 A=pi*D^2/4/144;
11 V=Q/A;
12 Rx=rho*Q*2*V*3^0.5/2;
13 Ry=rho*Q*2*(V-V);
14 R=sqroot(Rx^2+Ry^2);
15 disp(R,"resultant reaction (lbs)=");
16 clear

```

Scilab code Exa 5.7 efficiency

```

1
2 //example 5.7
3 //page 204
4 clc; funcprot(0);

```

```

5 //initialisation of variable
6 V1=40;// velocity
7 Vp=20;// velocity
8 pi=3.14;
9 th1=30/180*pi;// angle
10 th2=20/80*pi;// angle
11 g=9.81;
12 th=atan(V1*sin(th1)/(V1*cos(th1)-Vp));
13 V1r=V1*sin(th1)/sin(th);
14 V2r=V1r;
15 //on solving
16 phi=4/180*pi;
17 V2=V2r*sin(phi)/sin(th2);
18 V2w=V2*cos(th2);
19 W=(V2w+V1*cos(th1))*Vp/g;
20 disp(W,"work done per N of fluid(Nm)=");
21 Effi=1-(V2/V1)^2;
22 disp(Effi*100,"efficiency(%)=");
23 clear

```

Scilab code Exa 5.8 change in pressure

```

1
2 //example 5.8
3 //page 211
4 clc; funcprot(0);
5 //initialisation of variable
6 pi=3.14;
7 mdot=0.0022;//mas flow rate
8 V1=220*5280/3600;// velocity
9 V=12000/pi/6^2*4;// velocity
10 V4=2*V-V1;// velocity
11 //part1
12 F=mdot*(V4-V1)*12000;
13 disp(F,"thurst force (lbs)");

```

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

Chapter 6

Dimensional Analysis

Scilab code Exa 6.1 power of M, L, T

```
1
2 //example 6.1
3 //page 224
4 clc; funcprot(0);
5 //initialisation of variable
6 //part1;
7 //solving for powers of M,L,T
8 A=[1 0 0;-3 1 1;0 -1 0];
9 b=[-1;-1;2];
10 x=A\b;
11 disp("in non dimensional term")
12 disp(x(1),"power of M");
13 disp(x(2),"power of L");
14 disp(x(3),"power of T");
15 //part2
16 //solving for powers of M,L,T
17 A=[1 0 0;-3 1 1;0 -1 0];
18 b=[-1;1;1];
19 x=A\b;
20 disp("in non dimensional term")
21 disp(x(1),"power of M");
```



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

Scilab code Exa 6.2 velocity of model

```
1
2 //example 6.2
3 //page 233
4 clc; funcprot(0);
5 //initialisation of variable
6 rhom=998.2;//density
7 rhop=858.45;//density
8 mum=1.005*10^-3;//viscosity
9 mup=8/1000;//viscosity
10 Vp=2.5*10;//velocity
11 Vm=Vp*rhop*mum/mup/rhom;
12 disp(Vm,"velocity of model (m/s):");
13 clear
```

Scilab code Exa 6.3 Head over model

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

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

Chapter 7

Fluid Resistance

Scilab code Exa 7.1 reynolds number of glycerine flow

```
1
2 //example 7.1
3 //page 245
4 clc; funcprot(0);
5 //initialisation of variable
6 mug=8620/10000;//viscosity of glycerine
7 nuw=0.804*10^-6//kinematic viscosity of water
8 S=1.26;
9 rhog=995.7;//density of glycerine
10 rhow=1000;//density of water
11 D=0.02;
12 V=0.3;
13 Rw=V*D/nuw;
14 disp(Rw,"reynolds number of water flow");
15 disp("reynolds number greater than 2000 so flow
        turbulent");
16 Rg=V*D/mug*rhog;
17 disp(Rg,"reynolds number of glycerine flow");
18 disp("reynolds number less than 2000 so flow laminar
        ");
19 clear
```

Scilab code Exa 7.2 eddy viscosiy

```
1
2 //example 7.2
3 //page 245
4 clc; funcprot(0);
5 //initialisation of variable
6 y=0.3;
7 sigma=103; //stress
8 rho=1000; //density
9 k=0.7/y; //k=du/dy;
10 kappa=sqroot(sigma/rho/y^2/k^2);
11 l=kappa*y;
12 disp(1,"mixing length (m)");
13 neta=rho*l^2*k;
14 disp(neta,"eddy viscosiy (Nm/s^2)");
15 clear
```

Scilab code Exa 7.3 drag force

```
1
2 //example 7.3
3 //page 256
4 clc; funcprot(0);
5 //initialisation of variable
6 U=1; //speed
7 L=2; //length
8 rho=1260; //density
9 mu=0.862; //viscosity
10 tau=[0 0 0 0 0];
11 x=[0.1 0.5 1 1.5 2];
```

```

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

```

Scilab code Exa 7.4 drag force

```

1
2 //example 7.4
3 //page 256
4 clc; funcprot(0);
5 //initialisation of variable
6 mu=18.22*10^-6;
7 L=0.951;
8 rho=1.197;
9 U=8;//speed
10 L2=5;//length
11 drag=0.664*sqroot(mu*rho*U^3*L)+0.036*rho*U^2*L2*(mu
    /rho/U/L2)^(0.2)-0.036*rho*U^2*L*(mu/rho/U/L)
    ^0.2);
12 disp(drag,"drag force (N)");
13 clear

```

Scilab code Exa 7.5 drag force

```

1
2 //example 7.5
3 //page 270

```

```
4 clc; funcprot(0);
5 //initialisation of variable
6 S=1.26;
7 mu=0.862;
8 rho=1260;
9 pi=3.14;
10 Cd=35;
11 U=0.05;
12 D=0.01;
13 Re=rho*U*D/mu;
14 Fd=1/2*Cd*rho*U^2*pi*D^2/4;
15 disp(Fd,"drag force (N)");
16 clear
```

Scilab code Exa 7.6 drag force

```
1
2 //example 7.6
3 //page 272
4 clc; funcprot(0);
5 //initialisation of variable
6 A=50; //area
7 Cd=0.3;
8 U=11.11; //speed
9 rho=1.177;
10 Fd=1/2*Cd*rho*U^2*A;
11 disp(Fd,"drag force (N)");
12 clear
```

Chapter 8

Laminar Flow

Scilab code Exa 8.1 reynolds no.

```
1
2 //example 8.1
3 //page 288
4 clc; funcprot(0);
5 //initialisation of variable
6 L=10; //length
7 R=0.002; //radius
8 P1=200;
9 P2=260;
10 pi=3.14;
11 rho=0.81*1000;
12 mu=19.1/10000;
13 Sp=-(P1+0.81*6*9.81-P2)/L; //slope of pressue
14 taumax=R/2*Sp*1000;
15 disp(taumax,"maximum shear force (N/m^2)");
16 vmax=R^2/4/mu*Sp*1000;
17 disp(vmax,"maximum velocity (m/s)");
18 Q=pi*R^4/8/mu*Sp*1000;
19 disp(Q,"flow rate (m^3/s)");
20 R=vmax/2/mu*2*R*rho;
21 disp(R,"reynolds no.");
```

22 `clear`

Scilab code Exa 8.2 head loss

```
1
2 //example 8.2
3 //page 290
4 clc; funcprot(0);
5 //initialisation of variable
6 nu=1.54*10^-6;
7 V=0.1;
8 D=0.02;
9 g=9.81;
10 L=30;
11 Re=V*D/nu;
12 f=64/Re;
13 hf=f*L/D*V^2/2/g;
14 disp(hf,"head loss (m of H20)");
15 clear
```

Scilab code Exa 8.3 horse power required

```
1
2 //example 8.3
3 //page 290
4 clc; funcprot(0);
5 //initialisation of variable
6 Gamma=0.92*62.4;
7 nu=0.0205;
8 d=9/12;
9 pi=3.14;
10 g=32.2;
11 L=5280; //length
```



```

12 Q=50*2000/Gamma/3600;
13 A=pi*d^2/4;
14 V=Q/A;
15 Re=V*d/nu;
16 f=64/Re;
17 hf=f*L/d*V^2/2/g;
18 Hp=Gamma*Q*hf/550;
19 disp(Hp,"horse power required ");
20 clear

```

Scilab code Exa 8.4 viscosity

```

1
2 //example 8.4
3 //page 290
4 clc; funcprot(0);
5 //initialisation of variable
6 T=20*60;//time
7 L=10;
8 H1=5;
9 pi=3.14;
10
11 g=9.81*100;
12 D1=0.1;
13 A1=pi/4*D1^2;//area
14 A2=pi/4*5^2;//area
15 rho=0.88;//density
16 H2=5-50/A2;//height
17 mu=T*rho*A1*g/32/A2/L/log(5/2.45)*D1^2;
18 disp(mu,"viscosity (poise)");
19 clear

```

Scilab code Exa 8.5 shear stress on the plate

```

1
2 //example 8.5
3 //page 290
4 clc; funcprot(0);
5 //initialisation of variable
6 S=0.81;
7 mu=4/10^5;
8 Gamma=62.4*0.81;
9 P1=6.5*144+Gamma*4/2;
10 P2=8*144;
11 Sp=(P1-P2)/4;
12 q=integrate('2154.75*y-359125*y^2','y',0,0.006);
13 disp(q,"discharge per unit ft on the plate (ft^2/s)"
    );
14 k=2154.75-718250*0.006; //k=du/dy
15 tau=4*10^-5*k;
16 disp(tau,"shear stress on the plate (lbs/ft^2)");
17 clear

```

Chapter 9

Turbulent Flow in Pipes

Scilab code Exa 9.1 head loss

```
1
2 //example 9.1
3 //page 308
4 clc; funcprot(0);
5 //initialisation of variable
6 S=1.26;
7 mu=0.862//N.s/m^2
8 rhow=998;//density
9 rhog=1.26*998;//density of glycerine
10 Q=0.1;
11 g=9.81;
12 L=100;
13 D=0.2;
14 pi=3.14;
15 f=0.0688;//coeff of friction
16 A=pi*0.2^2/4;
17 V=Q/A;
18 R=V*D*rhog/mu;
19 hf=f*L/D*V^2/2/g;
20 disp(hf,"head loss if glucerine is flowing(m of
    glycerine)");
```

```

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

```

Scilab code Exa 9.2 flow rate

```

1
2 //example 9.2
3 //page 311
4 clc; funcprot(0);
5 //initialisation of variable
6 L=100; //length
7 D=0.2; //diameter
8 hf=5.43; //head loss
9 g=9.81
10 pi=3.14;
11 f=0.021 //friction coeff.
12 A=sqrt(2*g*D*hf/L); //area
13 V=A/sqrt(f);
14 Q=V*pi*D^2/4;
15 disp(Q,"flow rate (m^3/s)=");
16 clear

```

Scilab code Exa 9.3 diameter of the pipe

```

1
2 //example 9.3
3 //page 311

```

```

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

```

Scilab code Exa 9.4 head loss

```

1
2 //example 9.4
3 //page 318
4 clc; funcprot(0);
5 //initialisation of variable
6 L=500;
7 S=0.004; //slope of slope line
8 hf=S*L;
9 disp(hf,"head loss (ft)=");
10 clear

```

Scilab code Exa 9.5 head loss

```

1
2 //example 9.5
3 //page 319

```

```

4  clc; funcprot(0);
5  //initialisation of variable
6  epsilon=0.025;//roughness
7  L=500;
8  pi=3.14;
9  g=9.81;
10 D=30/100;
11 Q=0.1;
12 K=pi/4*sqrt(2*g)*(2*log10(D*100/epsilon)+1.14)*D
    ^2.5;
13 S=(Q/K)^2;
14 hf=S*L;
15 disp(hf,"head loss (m)=" );
16 clear

```

Scilab code Exa 9.6 flow rate

```

1
2 //example 9.6
3 //page 319
4 clc; funcprot(0);
5 //initialisation of variable
6 epsilon=0.025;//roughness
7 L=500;
8 pi=3.14;
9 g=9.81;
10 D=20/100;
11 Q=0.1;
12 S=5.43/100;
13 K=pi/4*sqrt(2*g)*(2*log10(D*100/epsilon)+1.14)*D
    ^2.5;
14 Q=K*sqrt(S);
15 disp(Q,"flow rate (m^3/s)=" );
16 clear

```

Scilab code Exa 9.7 diameter

```
1
2 //example 9.7
3 //page 320
4 clc; funcprot(0);
5 //initialisation of variable
6 epsilon=0.025; //roughness
7 L=500;
8 pi=3.14;
9 g=9.81;
10 Q=0.1;
11 S=5.43/100;
12 K=Q/sqroot(S);
13 //solving for D
14 deff('y=f(D)', 'y=3.14/4*sqrt(2*9.81)*(2*log10(D
    /0.025)+1.14)*D^2.5-.3');
15 [x]=fsolve(0.1, f);
16 disp(x, "diameter (m):");
17 clear
```

Scilab code Exa 9.8 total head loss

```
1
2 //example 9.8
3 //page 326
4 clc; funcprot(0);
5 //initialisation of variable
6 Q=0.075;
7 L=30;
8 D=0.1;
9 pi=3.14;
```

```

10 k=0.5;
11 K=10;
12 g=9.81;
13 nu=1.007*10^-6//kinematic viscosity
14 A=pi*D^2/4;
15 V=Q/A;
16 R=V*D/nu;
17 //using moody's chart
18 f=0.025;
19 hf1=f*L*V^2/2/g/D;//head loss by friction
20 hf2=k*V^2/2/g;//head loss due to contraction
21 hf3=K*V^2/2/g;//head loss due to expansion
22 hf=hf1+hf2+hf3;
23 disp(hf,"total head loss (m of H2O)=");
24 clear

```

Scilab code Exa 9.9 flow in pipe

```

1
2 //example 9.9
3 //page 329
4 clc; funcprot(0);
5 //initialisation of variable
6 nu=1.007*10^-6;
7 g=9.81;
8 hf=100;
9 pi=3.14;
10 //on solving V1 and V2 in terms of V3 and
11 // iterate for f1 and f2
12 //we get
13 f1=0.019;
14 f2=0.022;
15 V3=sqrt(2*g*hf/(8.4*f1+268.85*f2+4.85));
16 Q3=V3*pi*0.08^2/4;
17 disp(Q3,"flow in pipe 3(m^3/s)=");

```


18 `clear`

Scilab code Exa 9.10 length of pipe

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

Scilab code Exa 9.11 head loss

```
1
2 //example 9.11
3 //page 3337
4 clc; funcprot(0);
5 //initialisation of variable
6 Q=2;
7 nu=1.007*10^-56;
8 d2=0.3;
9 d1=0.5;
10 d3=0.15;
11 L1=500;
12 L2=200;
```

```

13 L3=300;
14 pi=3.14;
15 g=9.81;
16 f=0.018//(solved using iteration from moody's chart)
17 A1=pi*d1^2/4;
18 A2=pi*d2^2/4;
19 A3=pi*d3^2/4;
20 //assumption
21 q1=0.5;
22 q2=sqrt(L1*q1^2/d1^5*d2^5/L2);
23 q3=sqrt(L1*q1^2/d1^5*d3^5/L3);
24 Q1=2*q1/(q1+q2+q3);
25 hf=f*L1*Q1^2/A1^2/2/g/d1;
26 disp(hf,"head loss (m)=");
27 clear

```

Scilab code Exa 9.12 flow in pipe

```

1
2 //example 9.12
3 //page 340
4 clc; funcprot(0);
5 //initialisation of variable
6 L1=5000;
7 D1=1.5;
8 EL1=135;//energy level 1
9 L2=800;
10 D2=0.5;
11 EL2=120;
12 EL3=112;
13 L3=1500;
14 D3=0.75;
15 //using iteration junction height=131.6;
16
17 Q1=sqrt((EL1-131.6)/0.7594);

```

```
18 disp(Q1,"flow in pipe 1(m^3/s)");
19 Q2=sqrt((131.6-EL2)/36.33);
20 disp(Q2,"flow in pipe 2(m^3/s)");
21 Q3=sqrt((131.6-EL3)/8.168);
22 disp(Q3,"flow in pipe 3(m^3/s)");
23 clear
```

Scilab code Exa 9.13 flow in pipe

```
1
2 //example 9.13
3 //page 342
4 clc; funcprot(0);
5 //initialisation of variable
6 L1=5000;
7 D1=1.5;
8 EL1=136;//energy level 1
9 L2=800;
10 D2=0.5;
11 EL2=122;
12 EL3=110;
13 L3=1500;
14 D3=0.75;
15 //using iteration junction height=131;
16 j=131;
17 Q1=sqrt((EL1-j)/0.7594);
18 disp(Q1,"flow in pipe 1(m^3/s)");
19 Q2=sqrt((j-EL2)/36.33);
20 disp(Q2,"flow in pipe 2(m^3/s)");
21 Q3=sqrt((j-EL3)/8.168);
22 disp(Q3,"flow in pipe 3(m^3/s)");
23 clear
```

Scilab code Exa 9.14 minimum depth of ridge

```
1
2 //example 9.14
3 //page 349
4 clc; funcprot(0);
5 //initialisation of variable
6 z=100; //elevation
7 f=0.0125; //using iteration
8 L=10000;
9 L2=1000;
10 D=2;
11 g=32.2;
12 pi=3.14;
13 V=sqrt(2*g*z/f/L*D);
14 Q=pi*D^2/4*V;
15 x=34-10-f*L2*V^2/2/g/D-V^2/2/g;
16 disp(30-x,"minimum depth of ridge(ft)=");
17 clear
```

Chapter 10

Open Channel Flow

Scilab code Exa 10.1 section factor

```
1
2 //example 10.1
3 //page 363
4 clc; funcprot(0);
5 //initialisation of variable
6 z=0.5//slope
7 b=3;//breadth
8 y=2;//height
9 T=b+2*z*y;//top width
10 disp(T," top width(m)=");
11 A=(b+z*y)*y;//area
12 disp(A," area(m^2)=");
13 P=b+2*y*sqrt(1+z^2);
14 disp(P," Perimeter(m)=");
15 R=A/P;//hydraulic radius
16 disp(R," Hydraulic radius(m)=");
17 D=A/T//hydraulic depth
18 disp(D," Hydraulic depth(m)=");
19 Z=A*D^0.5;
20 disp(Z," section factor(m^2.5)=");
21 clear
```

Scilab code Exa 10.2 flow rate

```
1
2 //example 10.2
3 //page 366
4 clc; funcprot(0);
5 //initialisation of variable
6 z=1;
7 b=3;
8 y=1.5;
9 S=0.0009;
10 n=0.012;
11 A=(b+z*y)*y;
12 P=b+2*y*sqrt(1+z^2);
13 R=A/P;
14 Q=A/n*R^(2/3)*S^0.5;
15 disp(Q,"flow rate (m^3/s)");
16 clear
```

Scilab code Exa 10.3 height of water

```
1
2 //example 10.3
3 //page 367
4 clc; funcprot(0);
5 //initialisation of variable
6 Q=16.1;
7 b=3;
8 z=1;
9 S=0.0009;
10 //solving for y;
```

```

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

```

Scilab code Exa 10.4 width of bottom

```

1
2 //example 10.4
3 //page 372
4 clc; funcprot(0);
5 //initialisation of variable
6 S=1/1600;//slope of channel
7 Q=10000/60;
8 //on solving and simplifying
9 y=(Q/1.828/2.25/sqrt(0.5))^0.4;
10 b=0.828*y;
11 disp(b,"width of bottom(ft)=");
12 clear

```

Scilab code Exa 10.5 critical depth

```

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

```

Scilab code Exa 10.6 critical depth of water

```
1
2 //example 10.6
3 //page 380
4 clc; funcprot(0);
5 //initialisation of variable
6 z=0.5;
7 S=0.0008;
8 n=0.025;//manning's constant
9 Q=15;//flow rate
10 g=9.81;
11 //part1
12 //solving for y
13 deff('y=f(x)', 'y=(4+0.5*x)/0.025*x*((4+0.5*x)*x
14     /(4+2.236*x))^(2/3)*0.0008^0.5-15');
14 [x,v,info]=fsolve(1,f);
15 disp(x,"normal depth of water(ft)=");
16 clear
17 //part2
18 z=0.5;
19 S=0.0008;
20 n=0.025;//manning's constant
21 Q=15;//flow rate
22 g=9.81;
23 b=4;
24 y=2.22//depth of water
25 A=(b+z*y)*y;
26 T=b+2*z*y;
27 D=A/T;
28 V=Q/A;
29 F=V/sqroot(g*D);
30 disp(F,"Froude Number");
31 //part3
```



```

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

```

Scilab code Exa 10.7 Froude Number

```

1
2 //example 10.7
3 //page 382
4 clc; funcprot(0);
5 //initialisation of variable
6 z=0.7;
7 S=0.0004;
8 n=0.012;//manning's constant
9 Q=15;//flow rate
10 g=9.81;
11 b=4;
12 y=2.22//depth of water
13 A=(b+z*y)*y;
14 T=b+2*z*y;
15 D=A/T;
16 V=Q/A;
17 F=V/sqrroot(g*D);
18 disp(F,"Froude Number");
19 clear

```

Scilab code Exa 10.8 total loss of energy

```

1
2 //example 10.8
3 //page 391

```

```

4  clc; funcprot(0);
5  //initialisation of variable
6  b=60; //bottom width
7  y1=2.5; //depth
8  g=32.2;
9  Q=2500; //flow rate
10 Gamma=62.4 //unit weight
11 V1=Q/b/y1; //velocity
12 F1=V1/sqrt(g*y1);
13 k=0.5*(sqrt(1+8*F1^2)-1); //k=y1/y2
14 y2=k*y1; //depth
15 V2=Q/b/y2; //velocity
16 L=y2*4.25;
17 LE=y2+V2^2/2/g-y1-V1^2/2/g; //loss of energy
18 TL=Gamma*-LE*2500;
19 disp(TL,"total loss of energy(ft-lbs/s)");
20 clear

```

Scilab code Exa 10.9 depth of water

```

1
2 //example 10.9
3 //page 396
4 clc; funcprot(0);
5 //initialisation of variable
6 //solving for y
7 z=2; //trapezoid ratio
8 b=10; //base
9 n=0.012; //coeff
10 s=0.0002; //slope
11 Q=180; //discharge
12 l=5000; //distance
13 y(1)=10;
14 A(1)=(b+z*y(1))*y(1);
15 P(1)=b+2*y(1)*sqrt(1+z^2);

```

```

16 E(1)=y(1)+0.02;
17 Rbar(1)=0;
18 Abar(1)=0
19 Pbar(1)=0;
20 distance(1)=0;
21 delx(1)=0;
22 S(1)=0;
23 deff('y=f(x)', 'y=180^2*(10+4*x)/9.81/x^3/(10+2*x)
      ^3-1');
24 [x,v,info]=fsolve(1,f);
25 disp(x,"critical depth of water(ft)=");
26
27 //for the table
28 for i=2:6
29     y(i)=y(i-1)-0.2;
30     A(i)=(b+z*y(i))*y(i);
31     P(i)=b+2*y(i)*sqrt(1+z^2);
32     E(i)=y(i)+0.02;
33     Abar(i)=A(i-1)/2+A(i)/2;
34     Pbar(i)=P(i-1)/2+P(i)/2;
35     Rbar(i)=Abar(i)/Pbar(i);
36     S(i)=(n*Q/Abar(i)/Rbar(i)^(2/3))^2;
37     delx(i)=(E(i-1)-E(i))/(s-S(i));
38     distance(i)=distance(i-1)+delx(i);
39
40 end
41 printf("y      A      P      E      Abar
      Pbar      Rbar      S      delx      distace"
      );
42 //printing the table
43 for i=1:6
44     disp(i,"for row wise values of each parameter is
      for row=");
45     printf("      %.2f",y(i));
46     printf("      %.2f",A(i));
47     printf("      %.2f",P(i));
48     printf("      %.2f",E(i));
49     printf("      %.2f",Abar(i));

```

```

50     printf("      %.2 f",Pbar(i));
51     printf("      %.2 f",Rbar(i));
52     printf("      %.2 e",S(i));
53     printf("      %.2 f",delx(i));
54     printf("      %.2 f",distance(i));
55
56 end
57 y5000=y(5)-(distance(5)-1)/(distance(5)-distance(6))
      *0.2;
58 disp("");
59 disp(y5000,"the depth of water at distance 5000m in
      (m):")
60 clear

```

Scilab code Exa 10.10 depth of water

```

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

```

```

19 A(1)=(b+z*y(1))*y(1);
20 P(1)=b+2*y(1)*sqrt(1+z^2);
21 R(1)=A(1)/P(1);
22 T(1)=50;
23 delx(1)=0;
24 x(1)=0;
25 Fy(1)=(1-Q^2*T(1)/g/A(1)^3)/(s-(n*Q/Cm/A(1)/R(1)
      ^ (2/3))^2);
26
27 //for the table
28 for i=2:6
29     y(i)=y(i-1)-0.2;
30     A(i)=(b+z*y(i))*y(i);
31     P(i)=b+2*y(i)*sqrt(1+z^2);
32     R(i)=A(i)/P(i);
33     T(i)=T(1)-.8;
34     Fy(i)=(1-Q^2*T(i)/g/A(i)^3)/(s-(n*Q/Cm/A(i)/R(i)
      ^ (2/3))^2);
35     delx(i)=0.5*(Fy(i-1)+Fy(i))*0.2;
36     x(i)=x(i-1)+delx(i);
37
38 end
39 printf("      y          A          P          R          T
      F(y)      delx      x");
40 //printing the table
41 for i=1:6
42     disp(i,"for row wise values of each parameter is
      for row=");
43     printf("      %.2 f",y(i));
44     printf("      %.2 f",A(i));
45     printf("      %.2 f",P(i));
46     printf("      %.2 f",R(i));
47     printf("      %.2 f",T(i));
48     printf("      %. f",Fy(i));
49     printf("      %.2 f",delx(i));
50     printf("      %.2 f",x(i));
51
52 end

```

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

Scilab code Exa 10.11 force by water

```
1
2 //example 10.11
3 //page 395
4 clc; funcprot(0);
5 //initialisation of variable
6 yn=8.69; //depth
7 b=50; //width
8 Gamma=62.4; //unit weight
9 rho=1.94; //density
10 Q=4000; //flow rate
11 V=Q/b/yn;
12 Fs=0.5*Gamma*b*yn^2+rho*Q*V;
13 disp(Fs,"force by water(lbs)=");
14 clear
```

Scilab code Exa 10.12 flow rate

```
1
2 //example 10.12
3 //page 409
4 clc; funcprot(0);
5 //initialisation of variable
6 b=12; //width
7 y1=6; //depth
8 g=32.2;
```

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

Chapter 11

Compressible Flow

Scilab code Exa 11.1 perfect gas

```
1
2 //example 11.1
3 //page 420
4 clc; funcprot(0);
5 //initialisation of variable
6 T1=15+273;//temperature
7 T2=90+273;//temperature
8 Cp=0.24;//heat constant
9 W=10;//weight
10 H=W*Cp*(T2-T1);
11 disp(H,"Change in Enthalpy(kcal)=");
12 clear
```

Scilab code Exa 11.2 energy equation

```
1
2 //example 11.2
3 //page 420
```



```

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

```

Scilab code Exa 11.3 sound wave

```

1
2 //example 11.3
3 //page 422
4 clc; funcprot(0);
5 //initialisation of variable
6 P1=10;
7 P2=30;
8 T1=110+460;
9 k=1.4; //const
10 W=10;
11 Cv=0.157; //heat const
12 T2=T1*(P2/P1)^((k-1)/k);
13 H=W*Cv*(T2-T1);
14 disp(H,"Change in Enthalpy(Btu)=");
15 clear

```

Scilab code Exa 11.4 sound wave

```

1
2 //example 11.3
3 //page 426
4 clc; funcprot(0);
5 //initialisation of variable
6 //part1
7 S=1;
8 rho=S*1000; //density
9 Beta=2.2*10^9; //N/m^2
10 c=sqrt(Beta/rho);
11 disp(c,"speed of sound in water (m/s)=");
12 //part2
13 S=0.79;
14 rho=S*1000; //density
15 Beta=1.21*10^9; //N/m^2
16 c=sqrt(Beta/rho);
17 disp(c,"speed of sound in ethanol (m/s)=");
18 //part3
19 k=1.4;
20 R=287;
21 T=20+273; //temperature
22 c=sqrt(k*R*T);
23 disp(c,"speed of sound in air (m/s)=");

```

Scilab code Exa 11.5 downstream pressure

```

1
2 //example 11.5
3 //page 431
4 clc; funcprot(0);
5 //initialisation of variable
6 P1=1.5; //pressure
7 T1=500 //40F=500R in temperature
8 V1=1500;
9 k=1.4;

```

```
10 R=1716;
11 c1=sqroot(k*R*T1);
12 M1=V1/c1;
13 M2=sqroot((2+(k-1)*M1^2)/(2*k*M1^2-k+1));
14 P2=P1*(1+k*M1^2)/(1+k*M2^2);
15 disp(P2,"pressure downstream (psia)");
16 T2=T1*(1+0.5*(k-1)*M1^2)/(1+0.5*(k-1)*M2^2);
17 T2=T2-460;
18 disp(T2,"temperature downstream (Fahrenheit)");
19 clear
```

Chapter 12

Turbomachines

Scilab code Exa 12.1 efficiency

```
1
2 //example 12.1
3 //page 443
4 clc; funcprot(0);
5 //initialisation of variable
6 Q=0.25;
7 Gamma=9810*0.8;
8 pi=3.14;
9 H=25;
10 T=350; //torque
11 N=1800; //rpm
12 omega=N/60*2*pi;
13 neta=Gamma*Q*H/T/omega;
14 disp(neta*100," efficiency (%)");
15 clear
```

Scilab code Exa 12.2 power required

```

1
2 //example 12.2
3 //page 443
4 clc; funcprot(0);
5 //initialisation of variable
6 Q=0.4;
7 pi=3.14;
8 u2=31.4; //velocity
9 Gamma=9.81; //unit weight
10 g=9.81;
11 omega=2*pi*1500/60; //radial velocity
12 r2=0.2 //m
13 b2=0.03 //m
14 //part1
15 V2r=Q/2/pi/r2/b2; //radial velocity
16 V2t=u2-V2r*0.577;
17 v2=V2r/0.866; //speed
18 V2=sqrt(V2r^2+V2t^2);
19 disp(V2,"relative velocity (m/s):");
20 //part2
21 H=u2*V2t/g;
22 disp(H,"head of water (m)");
23 //part3
24 P=Gamma*Q*H;
25 disp(P,"power required (kW)");
26 clear

```

Scilab code Exa 12.3 rpm

```

1
2 //example 12.3
3 //page 450
4 clc; funcprot(0);
5 //initialisation of variable
6 Q1=82; //flow rate

```

```

7 Q2=100; //flow rate
8 H1=17.5; //head of water
9 H2=20; //head of water
10 d1=36; //diameter
11 N1=1500; //rpm
12 k1=Q2/Q1*N1*d1^3; //k1=N2*d2^3;
13 k2=H2/H1*N1^2*d1^2 //k2=N2^2*d2^2;
14 d2=(k1^2/k2)^(1/4);
15 disp(d2," diameter (cm)");
16 N2=k1/d1^3;
17 disp(N2," rpm");
18 clear

```

Scilab code Exa 12.4 specific speed

```

1
2 //example 12.4
3 //page 454
4 clc; funcprot(0);
5 //initialisation of variable
6 Q=500/449;
7 D=8/12;
8 pi=3.14;
9 g=32.2;
10 N=1800; //rpm
11 A=pi*D^2/4;
12 V=Q/A;
13 f=0.022 //from chart
14 HL=V^2/2/g*(12.1+224.9*f);
15 hs=HL+119.4;
16 Ns=N*sqrt(Q*449)/hs^0.75;
17 disp(Ns," specific speed (rpm)");
18 clear

```

Scilab code Exa 12.5 maximum value of suction lift

```
1
2 //example 12.5
3 //page 457
4 clc; funcprot(0);
5 //initialisation of variable
6 H=60;
7 sigma_critical=0.08;
8 Pa=98000;//pressure
9 Pv=1707;//pressure of vapour
10 Gamma=9810;
11 HL=1;
12 NPSH_min=H*sigma_critical;
13 Hs_max=Pa/Gamma-Pv/Gamma-NPSH_min-HL;
14 disp(Hs_max,"maximum value of suction lift (m)");
15 clear
```
