

Scilab Textbook Companion for
Fluid Mechanics - Worked Examples For
Engineers
by C. Schaschke¹

Created by
Tanushree Bobde
BE
Computer Engineering
Modern College of Engineering
College Teacher
Yogita Narwadkar
Cross-Checked by

July 31, 2019

¹Funded by a grant from the National Mission on Education through ICT, <http://spoken-tutorial.org/NMEICT-Intro>. This Textbook Companion and Scilab codes written in it can be downloaded from the "Textbook Companion Project" section at the website <http://scilab.in>

Book Description

Title: Fluid Mechanics - Worked Examples For Engineers

Author: C. Schaschke

Publisher: Warwickshire, U. K.

Edition: 1

Year: 2000

ISBN: 0852954050

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	4
1 Fluid Statics	5
2 Continuity Momentum and Energy	14
3 Laminar Flow and Lubrication	20
4 Dimensional Analysis	27
5 Flow measurement by differential head	28
6 Tank drainage and variable head flow	35
7 Open channels notches and weirs	41
8 Pipe friction and turbulent flow	48
9 Pumps	58

List of Scilab Codes

Exa 1.1	1	5
Exa 1.2	2	5
Exa 1.3	3	6
Exa 1.4	4	7
Exa 1.5	5	8
Exa 1.6	6	8
Exa 1.7	7	9
Exa 1.8	8	9
Exa 1.9	9	10
Exa 1.10	10	10
Exa 1.11	11	11
Exa 1.12	12	11
Exa 1.13	13	12
Exa 1.14	14	12
Exa 2.1	1	14
Exa 2.2	2	15
Exa 2.3	3	16
Exa 2.4	4	16
Exa 2.5	5	18
Exa 2.7	7	18
Exa 2.9	9	19
Exa 3.2	2	20
Exa 3.4	4	20
Exa 3.5	5	21
Exa 3.6	6	21
Exa 3.8	8	22
Exa 3.9	9	23
Exa 3.10	10	23

Exa 3.12	12	24
Exa 3.17	17	24
Exa 3.18	18	25
Exa 3.19	19	25
Exa 3.20	20	26
Exa 4.5	5	27
Exa 5.1	1	28
Exa 5.2	2	28
Exa 5.3	3	29
Exa 5.4	4	30
Exa 5.5	5	31
Exa 5.6	6	31
Exa 5.7	7	32
Exa 5.8	8	33
Exa 5.9	9	33
Exa 6.1	1	35
Exa 6.2	2	35
Exa 6.3	3	36
Exa 6.4	4	37
Exa 6.6	6	37
Exa 6.8	8	38
Exa 6.9	9	38
Exa 6.10	10	39
Exa 7.2	2	41
Exa 7.3	3	41
Exa 7.4	4	43
Exa 7.5	5	43
Exa 7.7	7	44
Exa 7.8	8	45
Exa 7.9	9	45
Exa 7.10	10	46
Exa 7.11	11	46
Exa 8.4	4	48
Exa 8.5	5	49
Exa 8.6	6	49
Exa 8.7	7	50
Exa 8.8	8	51
Exa 8.9	9	52

Exa 8.10	10	52
Exa 8.11	11	53
Exa 8.12	12	54
Exa 8.13	13	55
Exa 8.14	14	56
Exa 8.15	15	56
Exa 8.16	16	57
Exa 9.2	2	58
Exa 9.6	6	59
Exa 9.8	8	60
Exa 9.10	10	60
Exa 9.11	11	62
Exa 9.12	12	64
Exa 9.14	14	64
Exa 9.15	15	65

Chapter 1

Fluid Statics

Scilab code Exa 1.1 1

```
1 clc
2 rho=924; //kg/m^3
3 g=9.81; //m/s^2
4 H=2; //m
5 d=2; //depth in m
6
7 p=rho*g*H;
8 a=d*H;
9
10 F=p*a/2;
11 disp(" Total force exerted over the wall =")
12 disp(F)
13 disp("N")
```

Scilab code Exa 1.2 2

```
1 clc
2 p_v=50*10^3; //N/m^2
```

```

3 r=1; //m
4 p_atm=101.3*10^3; //N/m^2
5 rho=1000; //kg/m^3
6 H=2.5; //m
7 g=9.81; //m/s^2
8
9 F=p_v*%pi*r^2;
10 disp(" Total vertical force tending to lift the dome
    =")
11 disp(F)
12 disp("N")
13
14 p=p_atm+p_v+rho*g*H;
15 disp(" Absolute pressure at the bottom of the vessel
    =")
16 disp(p)
17 disp("N/m^2")
18
19 Fd=(p_v+rho*g*H)*%pi*r^2+rho*g*2*%pi*r^2/3;
20 disp("Downward force imposed by the gas and liquid =
    ")
21 disp(Fd)
22 disp("N")

```

Scilab code Exa 1.3 3

```

1 clc
2 a1=0.3; //m^2
3 m=1000; //kg
4 a2=0.003; //m^2
5 rho_oil=750; //kg/m^3
6 H=2; //m
7 g=9.81; //m/s^2
8
9 F1=m*g;

```

```

10 F2=a2*(F1/a1-rho_oil*g*H);
11 disp("The force on the plunger =")
12 disp(F2)
13 disp("N")

```

Scilab code Exa 1.4 4

```

1  clc
2  rho_0=800; //kg/m^3
3  rho_aq=1100; //kg/m^3
4
5  // rho_0*g*H=rho_aq*g*(H-0.5);
6
7  H=0.5*rho_aq/(rho_aq-rho_0);
8  disp("H=")
9  disp(H)
10 disp("m")
11
12 // For a fixed length of chamber of 3 m, the
    interface between the two phases is determined
    from the pressure in the chamber and discharge
    point.
13 // rho_0*g*H1+rho_aq*g*H2=rho_aq*g*(H-0.5);
14 // H=H1+H2
15
16 rho_0=600; //kg/m^3
17
18 H1=0.5*rho_aq/(rho_aq-rho_0);
19 disp("The lowest possible position of the inteiface
    in the chamber below the overflow.")
20 disp(H1)
21 disp("m")

```

Scilab code Exa 1.5 5

```
1  clc
2  rho_o=900; //kg/m^3
3  rho_n=1070; //kg/m^3
4  H=1; //m
5  g=9.81; //m/s^2
6  dp=10*10^3; //N/m^2
7
8  // H=H1+H2
9
10 H1=(dp-rho_n*g*H)/(rho_o-rho_n)/g;
11 disp("The position of the interface between the legs
    =")
12 disp(H1)
13 disp("m")
```

Scilab code Exa 1.6 6

```
1  clc
2  dp=22*10^3; //N/m^2
3  g=9.81; //m/s^2
4  H=1.5; //m
5  rho=1495; //kg/m^3
6  rho_s=1270; //kg/m^3
7  rho_c=2698; //kg/m^3
8
9  p=dp/g/H;
10 disp("the density of the solution with crystal =")
11 disp(p)
12 disp("kg/m^3")
13
14 // rho=f1*rho_s+f2*rho_c
15 // f1+f2=1
16
```

```
17 f2=(rho-rho_s)/(rho_c-rho_s);
18 disp("The fraction of crystals =")
19 disp(f2)
```

Scilab code Exa 1.7 7

```
1 clc
2 p_atm=101.3*10^3; // N/m^2
3 rho=1000; // kg/m^3
4 g=9.81; // m/s^2
5 H1=3; //m
6 a=0.073; // N/m
7 r1=5*10^(-4); //m
8
9 p1=p_atm+rho*g*H1+2*a/r1;
10
11 // p2=p_atm+rho*g*H2+2*a/r2;
12
13 // p1*4/3*%pi*r1^3=p2*4/3*%pi*r2^3
14
15 // Solving above two equations we get
16 r2=0.053; //mm
17 disp("Radius of the bubble =")
18 disp(r2)
19 disp("mm")
```

Scilab code Exa 1.8 8

```
1 clc
2 H=0.2; //m
3 rho=1000; //kg/m^3
4 rho_Hg=13600; //kg/m^3
5 g=9.81; //m/s^2
```

```

6
7 dp=(rho_Hg-rho)*g*H;
8 disp(" Differential pressure =")
9 disp(dp)
10 disp("N/m^2")

```

Scilab code Exa 1.9 9

```

1 clc
2
3 // p1-rho*g*(H+H1)=p2-rho*g*H1-rho_air*g*H
4
5 rho=1000;
6 g=9.81; // m/s^2
7 H=0.4; //m
8 dp=rho*g*H;
9 disp(" Pressure drop in the pipe =")
10 disp(dp)
11 disp("N/m^2")

```

Scilab code Exa 1.10 10

```

1 clc
2 dp=20*10^3; //N/m^2
3 rho_Hg=13600; //kg/m^3
4 rho=700; //kg/m^3
5 g=9.81; //m/s^2
6 d=0.02; //m
7
8 H=dp/(rho_Hg-rho)/g;
9
10 V=%pi/4*d^2*H;
11 disp(" Quantity of mercury to be removed =")

```

```
12 disp(V)
13 disp("m^3")
```

Scilab code Exa 1.11 11

```
1 clc
2 rho=800; //kg/m^3
3 g=9.81; //m/s^2
4 L=0.12;
5 theta=%pi/180*20; // radians
6
7 dp=rho*g*L*sin(theta);
8 disp("The gauge pressure across the filter =")
9 disp(dp)
10 disp("N/m^2")
```

Scilab code Exa 1.12 12

```
1 clc
2 mc=100; //kg
3 g=9.81; //m/s^2
4 rho=1000; //kg/m^3
5 rho_c=7930; //kg/m^3
6
7 m=mc*rho/rho_c;
8
9 F=mc*g-m*g;
10 disp("The tension in the cable =")
11 disp(F)
12 disp("N")
```

Scilab code Exa 1.13 13

```
1  clc
2  rho=1000;
3  x=0.06;
4  rho_0=800;
5  x_0=0.04;
6
7  L=(rho*x-rho_0*x_0)/(rho-rho_0);
8
9  rho_L=900;
10 x_L=L-rho/rho_L*(L-x);
11 disp("Length of the stem above the liquid of SG 0.9
    =")
12 disp(x_L)
13 disp("m")
```

Scilab code Exa 1.14 14

```
1  clc
2  m_s=5*10^6; //kg
3  T2=4.5; //m
4  T1=3; //m
5  rho_hc=950; //kg/m^3
6  Q=125; //m^3/h
7
8  m_hc=m_s*(T2/T1-1);
9  disp("Quantity delivered =")
10 disp(m_hc)
11 disp("kg")
12
13 t=m_hc/rho_hc/Q;
14 disp("Time taken =")
15 disp(t)
16 disp("hours")
```


Chapter 2

Continuity Momentum and Energy

Scilab code Exa 2.1 1

```
1  clc
2  Q1=0.02; //m^3/s
3  d1=0.15; //m
4  d2=0.05; //m
5  d3=0.1; //m
6  v2=3; //m/s
7
8
9  v3=(4*Q1/%pi-d2^2*v2)/d3^2;
10 disp("velocity at pipe 3 =")
11 disp(v3)
12 disp("m/s")
13
14 Q3=%pi*d3^2/4*v3;
15 disp("Flowrate at pipe 3 =")
16 disp(Q3)
17 disp("m^3/s")
18
19 Q2=%pi*d2^2/4*v2;
```

```

20 disp("Flowrate at pipe 2")
21 disp(Q2)
22 disp("m^3/s")
23
24 disp("Velocity at pipe 2")
25 disp(v2)
26 disp("m/s")
27
28 v1=4*(Q2+Q3)/%pi/d1^2;
29 disp("Velocity at pipe 1 =")
30 disp(v1)
31 disp("m/s")
32
33 disp("Flowrate at pipe 1")
34 disp(Q1)
35 disp("m^3/s")

```

Scilab code Exa 2.2 2

```

1  clc
2  d1=0.2; //m
3  d2=d1;
4  p1=1*10^5; //N/m^2
5  p2=80*10^3; //N/m^2
6  Q=150; //m^3/h
7  rho=900; //kg/m^3
8  theta1=0; //radians
9  theta2=%pi; //radians
10
11 a1=%pi*d1^2/4;
12 a2=%pi*d2^2/4;
13
14 F1=p1*a1; // Upstream force
15 F2=p2*a2; // Downstream force
16

```

```

17 v1=4*Q/3600/%pi/d1^2;
18 v2=v1;
19
20 flux=rho*Q/3600*v2; //Momentum flux
21
22 Fx=F1*cos(theta1)-F2*cos(theta2)+flux*(cos(theta2) -
      cos(theta1));
23 Fy=F1*sin(theta1)-F2*sin(theta2)-flux*(sin(theta2)-
      sin(theta1));
24
25 F=sqrt(Fx^2+Fy^2);
26 disp(" Force exerted by the liquid on the bend =")
27 disp(F)
28 disp("N")

```

Scilab code Exa 2.3 3

```

1 clc
2 rho=1000; //kg/m^3
3 d=0.05; //m
4 L=500; //m
5 v=1.7; //m/s
6
7 a=%pi*d^2/4;
8 F=rho*a*L*v;
9
10 P=F/a/10^3;
11 disp(" Average pressure =")
12 disp(P)
13 disp("kN/m^2")

```

Scilab code Exa 2.4 4

```

1  clc
2  g=9.8; //m/s^2
3  dz=0.2; //m ; dz1=z1-z2=z1-z2
4  rho=1000; //kg/m^3
5  dz1=2; //m ; dz1=z1-z_A
6  dz2=0; //m ; dz2=z1-z_B
7  dz3=-1.5; //m ; dz3=z1-z_C
8
9  v2=sqrt(2*g*dz);
10
11 v_A=v2;
12 v_B=v2;
13 v_C=v2;
14
15 p_A=rho*g*(dz1-v_A^2/2/g);
16 p_B=rho*g*(dz2-v_B^2/2/g);
17 p_C=rho*g*(dz3-v_C^2/2/g);
18
19 disp(" Velocity at pt. A =")
20 disp(v_A)
21 disp("m/s")
22
23 disp(" Velocity at pt. B =")
24 disp(v_B)
25 disp("m/s")
26
27 disp(" Velocity at pt. C =")
28 disp(v_C)
29 disp("m/s")
30
31 disp(" Pressure at pt. A =")
32 disp(p_A)
33 disp("kN/m^2")
34
35 disp(" Pressure at pt. B =")
36 disp(p_B)
37 disp("kN/m^2")
38

```

```
39 disp(" Pressure at pt. C =")
40 disp(p_C)
41 disp(" kN/m^2")
```

Scilab code Exa 2.5 5

```
1 clc
2 Q=10; // m^3/hr
3 d1=0.05; //m
4 d2=0.1; //m
5 rho=1000; //kg/m^3
6
7 a1=%pi*d1^2/4;
8 a2=%pi*d2^2/4;
9
10 v1=Q/3600/a1;
11 v2=(d1/d2)^2*v1;
12
13 PD=rho*Q/3600*(v1-v2)/a2;
14 disp(" Pressure drop =")
15 disp(PD)
16 disp("N/m^2")
```

Scilab code Exa 2.7 7

```
1 clc
2 Q=100; //m^3/hr
3 d1=0.2; //m
4 d2=0.15; //m
5 p1=80*10^3; //N/m^2
6 rho=1000; //kg/m^3
7 g=9.8; //m/s^2
8
```

```

9 a1=%pi*d1^2/4;
10 a2=%pi*d2^2/4;
11 v1=Q/3600/a1;
12 v2=Q/3600/a2;
13 H_L=0.2*v2^2/2/g;
14 p2=p1+rho/2*(v1^2-v2^2)-rho*g*H_L;
15
16 F_u=p1*a1; // Upstream force
17 F_d=p2*a2; // Downstream force
18
19 F_x=rho*Q/3600*(v2-v1)-F_u+F_d;
20 disp("Force required =")
21 disp(F_x)
22 disp("N")

```

Scilab code Exa 2.9 9

```

1 clc
2 N=60; //rpm
3 r2=0.25; //m
4 g=9.8; //m/s^2
5
6 w=2*pi*N/60;
7 dz_12=(w*r2)^2/2/g; // dz_12=z2-z1
8 c=w*r2^2;
9 dz_23=c^2/2/g/r2^2; // dz_23=z3-z2
10
11 dz_13=dz_23+dz_12;
12 disp("Total depression =")
13 disp(dz_13)
14 disp("m")

```

Chapter 3

Laminar Flow and Lubrication

Scilab code Exa 3.2 2

```
1 clc
2 Re=2000;
3 d=0.008; //m
4
5 L1=0.058*Re*d;
6 disp("The furthest distance the fluid can flow into
       the 8 mm inside diameter pipe before fully
       developed laminar flow can exist is ");
7 disp(L1);
8 disp("m");
```

Scilab code Exa 3.4 4

```
1 clc
2 del_p=90*103; // N/m2
3 d=0.126; // m
4 R=0.126/2; // m
5 u=1.2;
```

```

6 L=60; // m
7 Rho=1260;
8
9 Q=%pi * del_p * R^4 / (8*u*L);
10 disp("The glycerol delivery rate is ");
11 disp(Q);
12 disp("m^3/s");
13
14 Re=4*Rho*Q/(u*pi*d);
15 disp("The Reynolds number is ");
16 disp(Re);
17 disp("As Re is below 2000, therefore confirming
    laminar flow.");

```

Scilab code Exa 3.5 5

```

1 clc
2 u=0.015; //Ns/m^2
3 Q=0.004/60; //m^3/s
4 dp=100;
5 rho=1100; //kg/m^3
6
7 R=(8*u*Q/(%pi*dp))^(1/4);
8 Re=(4*rho*Q/(%pi*u*(2*R)));
9
10 disp("Diameter of the pipe =")
11 disp(R)
12 disp("m")
13
14 disp("Reynolds number =")
15 disp(Re)

```

Scilab code Exa 3.6 6

```

1  clc
2  u=0.03; //Ns/m^2
3  Q=10^(-7); //m^3/s
4  dp=integrate('8*u*Q/%pi/0.005^4/(1-L)^4', 'L', 0,
5              0.5)
6  disp("Pressure difference =")
7  disp(dp)
8  disp("N/m^2")

```

Scilab code Exa 3.8 8

```

1  clc
2  u=0.1; // Ns/m^2
3  d=0.1; //m
4  R=0.05; // m
5  Rho=900; //kg/m^3
6
7  v_max=2; // m/s
8  v=v_max/2; // m/s
9
10 disp("At the pipe wall (r =R), therefore , the shear
11     stress is");
12 Tw=-2*u*v_max/R;
13 disp(Tw);
14 disp("N/m^2");
15 disp("The negative sign indicates that the shear
16     stress is in the opposite direction to flow.");
17
18 del_p=4*u*v_max/R^2;
19 disp(del_p);
20 disp("N/m");

```

Scilab code Exa 3.9 9

```
1 clc
2 u=0.032; // Ns/m^2
3 Re=2000; // maximum value
4 Rho=854;
5 del_p=150; // N/m^2
6
7 d=(32*u^2*Re/(Rho*del_p))^(1/3);
8 disp("The maximum inside diameter is found to be ")
9 disp(d)
10 disp("m")
```

Scilab code Exa 3.10 10

```
1 clc
2 rho=1000; //kg/m^3
3 u=0.1; //Ns/m^2
4 g=9.81; //m/s^2
5 L=10; //m
6 H=2; //m
7 Q=14/3600; //m^3/s
8 d=0.05; //m
9
10 dp=rho*g*(L+H) - (128*Q*u*L/%pi/0.05^4);
11 disp("Pressure drop across the valve =")
12 disp(dp)
13 disp("N/m^2")
```

Scilab code Exa 3.12 12

```
1  clc
2  Q=3*10^(-6); // m^3/s
3  u=0.001; // Ns/m^2
4  W=1;
5  rho=1000; // kg/m^3
6  g=9.81; // m/s^2
7  d=1.016*10^(-4); // m
8
9  theta=asind(3*Q*u/W/rho/g/d^3);
10 disp("Exact angle of inclination =")
11 disp(theta)
12
13 d1=1.25*10^(-4); // m
14
15 u1=W*rho*g*sind(theta)*(d1^3)/(3*Q);
16 disp("Viscosity of the second liquid =")
17 disp(u1)
18 disp("Ns/m^2")
```

Scilab code Exa 3.17 17

```
1  clc
2  u=1.5; // Ns/m^2
3  v=0.5; // m/s
4  H=0.02/2; // m
5
6  t=-u*3*v/H;
7  disp("The shear stress =")
8  disp(t)
9  disp("N/m^2")
10 disp("It acts in the opposite direction to the flow.
    ")
```

Scilab code Exa 3.18 18

```
1  clc
2  N=600/60; // revolutions per sec
3  r=0.025; // m
4  t=400; // N/m^2
5  l=0.002; // m
6
7  w=2*%pi*N;
8
9  u=t*l/w/r;
10 disp("Viscosity =")
11 disp(u)
12 disp("Ns/m^2")
13
14 T=integrate('2*%pi*u*w/l*r^3', 'r', 0, r);
15 disp("Torque =")
16 disp(T)
17 disp("Nm")
```

Scilab code Exa 3.19 19

```
1  clc;
2  u=0.153; //Ns/m^2
3  r=0.05; // m
4  N=30; // rps
5  t=2/10^5; //s
6  L=0.2; // m
7
8  tau=u*(2*%pi*N*r/t);
9
10 F=tau*2*%pi*r*L;
```

```

11
12 T=F*r;
13
14 w=2*%pi*N;
15 P=T*w;
16
17 disp("The torque on the bearing is found to be ");
18 disp(T);
19 disp("Nm");
20 disp("and the power required to overcome the
    frictional resistance is ");
21 disp(P);
22 disp("W");

```

Scilab code Exa 3.20 20

```

1  clc;
2  t=0.0005; // s
3  P=22; //
4  r=300/60; //
5  R_1=0.1; //
6  R_2=0.0625; //
7
8  w=2*%pi*r;
9
10 u=2*t*P/(%pi*w^2*((R_1)^4-(R_2)^4));
11 disp("The viscosity of the oil is found to be ");
12 disp(u);
13 disp("Nsm-2.");

```

Chapter 4

Dimensional Analysis

Scilab code Exa 4.5 5

```
1  clc
2  Rho_full=800; // kg/m^3
3  v_full=1.8; // m/s
4  u_full=9*10^(-4); // Nm/s^2
5  Rho_model=1000; // kg/m^3
6  u_model=10^(-3); // Ns/m^2
7  d_full= 2;
8  d_model=1;
9  del_p_fmodel=4000; // N/m^2
10
11 v_model = (((Rho_full * v_full)/u_full)/(Rho_model/
    u_model))*(d_full/d_model);
12
13 del_p_f=del_p_fmodel*Rho_full*(v_full)^2/Rho_model/(
    v_model)^2;
14 disp("The pressure drop per unit length in the full-
    scale pipe is expected to be ")
15 disp(del_p_f)
16 disp("kN/m^2");
```

Chapter 5

Flow measurement by differential head

Scilab code Exa 5.1 1

```
1 clc
2 rho_m=840; //kg/m^3
3 g=9.8; //m/s^2
4 H=0.03; //m
5 rho=1.2; //kg//m^3
6
7 dp=rho_m*g*H;
8
9 v1=sqrt(2*dp/rho);
10 disp(" Velocity =")
11 disp(v1)
12 disp("m/s")
```

Scilab code Exa 5.2 2

```
1 clc
```

```

2 r=[0 0.05 0.10 0.15 0.20 0.225 0.25];
3 v=[19 18.6 17.7 16.3 14.2 12.9 0];
4
5 // We define a new variable dQ=v*2*%pi*r. According
   to the given values of r, v, we get dQ as follows
6 dQ=[0 5.8 11.1 15.4 17.8 18.2 0];
7 plot(r,dQ)
8 xtitle("", "Radius", "v*2*%pi*r")
9 // From the graph area under the curve comes out to
   be 2.74
10 Q=2.74; // m^3/s
11 disp(" Rate of flow =")
12 disp(Q)
13 disp("m^3/s")
14
15 d=0.5; // m
16
17 v=4*Q/%pi/d^2;
18 disp(" Average velocity =")
19 disp(v)
20 disp("m/s")

```

Scilab code Exa 5.3 3

```

1 clc
2 d1=0.1; //m
3 rho_Hg=13600; //kg/m^3
4 rho=1000; //kg/m^3
5 g=9.81; //m/s^2
6 H=0.8; //m
7 Cd=0.96;
8 Q=0.025; //m^3/s
9
10 a=%pi*d1^2/4;
11 dp=(rho_Hg-rho)*g*H;

```

```

12
13 B=((2*dp/(rho*((Q/Cd/a)^2)))+1)^(1/4);
14
15 d2=d1/B;
16 disp("Throat diameter =")
17 disp(d2)
18 disp("m")
19
20 // The shortest possible overall length of venturi
    is therefore an entrance cone of 7.1 cm length
    (20 degrees), a throat of 2.5 cm(0.25 pipe-
    diameters) and an exit cone of 19.7 cm (7.5
    degrees) giving an overall length of 29.3 cm.
21
22 L=29.3; //cm
23 disp("Overall Length =")
24 disp(L)
25 disp("m")

```

Scilab code Exa 5.4 4

```

1  clc
2  Cd_o=0.65;
3  d=0.05;
4  d_o=0.025;
5  Cd_v=0.95;
6  d_v=0.038;
7
8  // (Q_o/Cd_o)^2*((d/d_o)^4 - 1)=(Q_v/Cd_v)^2*((d/d_v
    )^4 - 1)
9
10 // Q_v=4*Q_o
11 // Q = Q_v + Q_o
12 // Q = 5*Q_v
13 Q1=20;

```

```

14 Q2=100-Q1;
15
16 disp("Flow through orifice =")
17 disp(Q1)
18 disp("%")
19
20 disp("Flow through venturi =")
21 disp(Q2)
22 disp("%")
23 disp("Thus 20 % of the flow passes through the
      orifice meter while 80 % of the flow passes
      through the venturi.")

```

Scilab code Exa 5.5 5

```

1  clc
2  Qa=0.003/60; // m^3/s
3  Ca=20; // g/l
4  Co=0.126; // g/l
5  dp=3700; // N/m^2
6  p=1000; // N/m^2
7  d=0.1; // m
8
9  a=%pi*d^2/4;
10 Qi=Qa*((Ca-Co)/Co);
11 Q=Qi+Qa;
12 B=10/6;
13
14 Cd=Q/a/sqrt(2*dp/p/(B^4-1));
15 disp("Coefficient of discharge =")
16 disp(Cd)

```

Scilab code Exa 5.6 6

```

1  clc
2  rho=850; // kg/m^3
3  Q=0.056; // m^3/s
4  Cd=0.98;
5  d1=0.2; // m
6  d2=0.1; // m
7  g=9.81; // m/s^2
8  dz=0.3; // m
9
10 a=%pi*(d1)^2/4;
11
12 dp=rho/2*((Q/Cd/a)^2*((d1/d2)^4 - 1) + 2*g*(dz));
13 disp("The differential pressure =")
14 disp(dp)
15 disp("N/m^2")

```

Scilab code Exa 5.7 7

```

1  clc
2  g=9.81; // m/s^2
3  H=0.5; // m
4  rho_m=1075; // kg/m^3
5  rho=860; // kg/m^3
6  B=0.225/0.075;
7  a1=%pi/4*(0.225)^2;
8  Cd=0.659;
9
10 v_t=sqrt(2*g*H*(rho_m-rho)/rho/(B^4-1));
11
12 Q=Cd*a1*v_t;
13 disp("Rate of flow =")
14 disp(Q)
15 disp("m^3/s")

```

Scilab code Exa 5.8 8

```
1 clc
2 m_f=0.03; // kg
3 rho_f=5100; // kg/m^3
4 d_l=0.3; // m
5 d_b=0.22; // m
6 H_tube=0.2; // m
7 Cd=0.6;
8 H=0.1; // m
9 g=9.81; // m/s^2
10 rho=1000; // kg/m^3
11
12 V_f=m_f/rho_f;
13
14 theta=2*atan((d_l-d_b)/2/H_tube);
15
16 m=Cd*H*tan(theta/2)*sqrt(8*V_f*g*rho*(rho_f-rho)*%pi
    );
17 disp("Mass flowrate =")
18 disp(m)
19 disp("kg/s")
```

Scilab code Exa 5.9 9

```
1 clc
2 d1=0.05; // m
3 d2=0.025; // m
4 Cd=0.97;
5 dp=1200; // N/m^2
6 rho=1000; // kg/m^3
7 H=0.15; // m
```

```

8 theta=2; // degrees
9 V_f=10^(-4); // m^3
10 g=9.81; // m/s^2
11 rho_f=8000; // kg/m^3
12
13 B=d1/d2;
14 a=%pi/4*d1^2;
15
16 Q=Cd*a*sqrt(2*dp/rho/(B^4-1));
17 disp("Flow rate of water =")
18 disp(Q)
19 disp("m^3/s")
20
21 Cd=Q/(H/rho*tand(theta/2)*sqrt(8*V_f*g*rho*(rho_f -
    rho)*%pi));
22 disp("Coefficient of discharge of the rotameter =")
23 disp(Cd)

```

Chapter 6

Tank drainage and variable head flow

Scilab code Exa 6.1 1

```
1 clc;  
2 Q=5000/3600/24; // m^3 per second  
3 C_d=0.6;  
4 r=0.01/2; // m  
5 g=9.8; // m/s^2  
6 H=0.2; // m  
7 a_o=%pi*r^2;  
8  
9 n=Q/C_d/a_o/sqrt(2*g*H);  
10 disp("The number of orifices required are")  
11 disp(n);
```

Scilab code Exa 6.2 2

```
1 clc;  
2 x=0.86; // m
```

```

3 g=9.8; // m/s
4 y=0.96; // m
5 H=0.2; // m
6
7
8 v_act=x*sqrt(g/2/y);
9
10 v=sqrt(2*g*H);
11
12 Cv=v_act/v;
13 disp("The coefficient of velocity for the orifice is
        found to be")
14 disp(Cv);

```

Scilab code Exa 6.3 3

```

1 clc;
2 Vt=1; // m^3
3 d_t=1; // m
4 C_d=0.6;
5 d_o=0.02; // m
6 g=9.8; // m/s^2
7 a_o=%pi*(d_o)^2/4;
8
9 A=%pi*(d_t)^2/4;
10
11 H1=4*Vt/%pi/(d_t)^2;
12
13 t=A/C_d/a_o*sqrt(2*H1/g);
14 disp("Total drainage is found to take ")
15 disp(t)
16 disp(" seconds");

```

Scilab code Exa 6.4 4

```
1  clc;
2  C_d=0.6;
3  d_o=0.05; // m
4  g=9.8; // m/s^2;
5  R=2; //
6  H1=1.5; //
7
8  a_o=%pi*d_o^2/4;
9
10 t=%pi/C_d/a_o/sqrt(2*g)*(4/3*R*H1^(3/2)-2/5*H1^(5/2)
    );
11 disp("The time to drain the tank is found to be ")
12 disp(t);
13 disp("seconds");
```

Scilab code Exa 6.6 6

```
1  clc
2  Cd=0.62;
3  a=0.01; // m^2
4  g=9.81; // m/s^2
5  H=0.3; // m
6  A1=4*2; // m^2
7  H1=0.3; // m
8  H2=0.1; // m
9  A2=2*2; // m^2
10
11 Q=Cd*a*sqrt(2*g*H);
12 disp("The rate of flow =")
13 disp(Q)
14 disp("m^3/s")
15
16 t=2*A1*(H1^(1/2)-H2^(1/2))/(Cd*a*sqrt(2*g)*(1+A1/A2))
```

```

    );
17 disp("The time taken to reduce the difference in
    levels to 10 cm is ")
18 disp(t)
19 disp("s")

```

Scilab code Exa 6.8 8

```

1  clc;
2  Qs=0.4; // m^3/s
3  H1=1.5; // m
4  Q=0.2; // m^3/s
5  H2=0.5; // m
6  l=15; // m
7  b=10; // m
8  A=l*b;
9
10 k=Qs*H1^(-1/2);
11
12
13 t=-2*A/k^2 *(Q*log((Q-k*(H2)^0.5)/(Q-k*(H1)^0.5))+k
    *((H2)^0.5-(H1)^0.5));
14 disp("The time required for the level in the tank to
    fall to 1 m is ")
15 disp(t)
16 disp("second")

```

Scilab code Exa 6.9 9

```

1  clc
2  Cd=0.62;
3  d=0.05;
4  a_o=%pi*d^2/4;

```

```

5 g=9.81; // m/s^2
6
7 k=Cd*a_o*sqrt(2*g);
8
9 // We have got two simultaneous equations
10
11 // Q-k*0.65^(1/2)=0.1/90*A
12 // Q-k*1.225^(1/2)=0.05/120*A
13
14 M=[1 -0.1/90;1 -0.05/120];
15 N=[k*0.65^(1/2);k*1.225^(1/2)];
16
17 X=inv(M)*N;
18
19 Q=X(1,1);
20 A=X(2,1);
21
22 disp("The Area of the tank =")
23 disp(A)
24 disp("m^2")
25
26 disp("Flowrate =")
27 disp(Q)
28 disp("m^3/s")

```

Scilab code Exa 6.10 10

```

1 clc
2 H1=1.5; // m
3 V=0.75; // m^3
4 d1=1.2; // m
5 u=0.08; // Ns/m^2
6 L=3; // m
7 rho=1100; // kg/m^3
8 g=9.81; // m/s^2

```

```
9 d=0.025; // m
10
11 a=%pi*d^2/4;
12 A=%pi*d1^2/4;
13 H2=H1-(V/A);
14
15 t=-32*u*L*A/(a*rho*g*d^2)*log(H2/H1);
16
17 disp("Time taken =")
18 disp(t)
19 disp(" s")
```

Chapter 7

Open channels notches and weirs

Scilab code Exa 7.2 2

```
1  clc;  
2  l=1; // m  
3  b=0.3; // m  
4  n=0.014; // s/m^(1/3)  
5  i=1/1000;  
6  
7  A=l*b;  
8  P=2*b+l;  
9  m=A/P;  
10  
11 Q=A/n*m^(2/3)*sqrt(i);  
12 disp("The delivery of water through the channel is  
    found to be ")  
13 disp(Q)  
14 disp("m^3/s")
```

Scilab code Exa 7.3 3

```
1  clc
2  n=0.015; //  $m^{(-1/3)}s$ 
3  i=1;
4  H=[4.0 4.1 4.2 4.13];
5
6  A=12*H;
7  P=12+2*H;
8  m=A/P;
9  C=m^(1/6)/n;
10
11 Q=C*A*sqrt(m*i);
12
13 // An analytical solution for depth H is not
    possible. It is therefore necessary to use a
    graphical or trial and error approach.
14
15 // The corresponding values of A, P, MHD (m), Q are
    given below as per the taken values of H.
16 A=[48 49.2 50.4 49.56];
17 P=[20 20.2 20.4 20.26];
18 m=[2.4 2.44 2.47 2.45];
19 Q=[57.36 59.38 61.39 59.98];
20
21 plot(H,Q)
22
23 r=[4.13 4.13];
24 s=[57 60];
25 plot(r,s, 'r ')
26
27 t=[4 4.13];
28 u=[60 60];
29 plot(t,u, 'r ')
30
31 xtitle("", "Depth H", "Flowrate Q")
32
33 // Therefore the depth is found to be approximately
```

4.13

```
34
35 depth=4.13; //m
36 disp("Depth = ")
37 disp(depth)
38 disp("m")
39
40 C1=(2.45)^(1/6)/n;
41 disp("Chezy Coefficient =")
42 disp(C1)
```

Scilab code Exa 7.4 4

```
1 clc;
2 Q=300/60; // m^3/s
3 i=1/1600;
4
5 H=(Q/140*sqrt(2/i))^(2/3);
6
7 A=2*H^2;
8 disp("The minimum flow area is found to be ")
9 disp(A)
10 disp("m^2")
```

Scilab code Exa 7.5 5

```
1 clc
2 d=0.9144; // m
3 C=100; // m^(1/2)s^(-1)
4 R=d/2;
5
6 H=[0.1 0.15 0.2 0.25 0.201];
7
```

```

8 theta=acos((R-H)/R);
9 A=R^2*(theta-sin(2*theta)/2);
10 P=2*R*theta;
11 m=A/P;
12
13 // An analytical solution for depth H is not
    possible. It is therefore necessary to use a
    graphical or trial and error approach.
14
15 // The corresponding values of theta , A, P, MHD (m) ,
    Q are given below as per the taken values of H.
16
17 theta=[0.674 0.834 0.973 1.101 0.975];
18 A=[0.039 0.070 0.106 0.146 0.107];
19 P=[0.616 0.763 0.890 1.006 0.891];
20 m=[0.063 0.092 0.119 0.145 0.120];
21 Q=[248.7 543.2 932.2 1412.9 940.0];
22
23 plot(H,Q)
24
25 i=[0.201 0.201];
26 j=[0 940];
27 plot(i,j,'r')
28
29 k=[0 0.201];
30 l=[940 940];
31 plot(k,l,'r')
32
33 xtitle("", "Depth H", "Flowrate Q")
34
35 Depth=0.201; // m
36 disp("The depth in the channel =")
37 disp(Depth)
38 disp("m")

```

Scilab code Exa 7.7 7

```
1 clc ;
2 Cd=0.56;
3 B=1.2; // m
4 g=9.8; // m/s^2
5 H=0.018; // m
6
7 Q=2/3*Cd*B*sqrt(2*g)*H^(3/2);
8 disp("The rate of flow of liquid over the weir is ")
9 disp(Q)
10 disp("m^3/h")
```

Scilab code Exa 7.8 8

```
1 clc ;
2 H2=5.5;
3 Q1=217;
4 Q2=34;
5 H1=8.5;
6
7 H0=(H2*(Q1/Q2)^(2/3)-H1)/((Q1/Q2)^(2/3)-1);
8 disp("The height of the weir crest above the surface
9 of the river is found to be ")
9 disp(H0)
10 disp("m")
```

Scilab code Exa 7.9 9

```
1 clc
2 H=0.07; // average head
3 rate=-0.02/600; // (dH/dt)
4 H1=0.08; // m
```

```

5 H2=0.01; // m
6
7 k=-rate/H^(3/2);
8
9 t=integrate(' -1/k*H^(-3/2)', 'H', H1, H2);
10 disp("Time taken =")
11 disp(t)
12 disp(" s")

```

Scilab code Exa 7.10 10

```

1 clc
2 Cd=0.62;
3 g=9.81; // m/s^2
4 H=0.03; // m
5
6 Q=8/15*Cd*sqrt(2*g)*H^(5/2);
7 disp("Rate of flow =")
8 disp(Q)
9 disp("m^3/s")

```

Scilab code Exa 7.11 11

```

1 clc
2 l=4; // m
3 b=2; // m
4 H1=0.15; // m
5 H2=0.05; // m
6
7 t=integrate(' -l*b/1.5*H^(-5/2)', 'H', H1, H2);
8 disp("Time taken to reduce the head in the the tank
   =")
9 disp(t)

```

10 `disp(" s")`

Chapter 8

Pipe friction and turbulent flow

Scilab code Exa 8.4 4

```
1  clc
2  rho=867; // kg/m^3
3  Q=12/3600; // m^3/s
4  u=7.5*10^(-4); // Ns/m^2
5  L=200; // m
6  H=10; // m
7  g=9.81; // m/s^2
8
9  d=(H*2*g/(4*0.079*(4*rho*Q/%pi/u)^(-1/4)*L*(4*Q/%pi)
    ^2))^(-4/19);
10 disp("Internal diameter of the pipeline =")
11 disp(d)
12 disp("m")
13
14 Re=4*rho*Q/%pi/d/u;
15 disp("Re =")
16 disp(Re)
17 disp("The value of Reynolds number lies between 4000
    and 10^5, confirming the validity of using the
    Blasius equation for smooth-walled pipes")
```

Scilab code Exa 8.5 5

```
1  clc
2  m=40/60; // kg/s
3  rho=873; // kg/m^3
4  d=0.025; // m
5  u=8.8*10^-4; // Ns/m^2
6  dp=55*10^3; //N/m^2
7  L=18; // m
8  g=9.81; // m/s^2
9
10 v2=4*m/rho/%pi/d^2;
11 Re=rho*v2*d/u;
12
13 // According to this value of Re, Prandtl's equation
    is satisfied.
14 //  $1/\sqrt{f}=4*\log(Re*\sqrt{f})-0.4$ 
15 // By trial and error method we get friction factor
    equal to
16 f=0.0055;
17
18 H=dp/rho/g + v2^2/2/g + v2^2/2/g*(4*f*L/d+1.5);
19 disp("The minimum allowable height =")
20 disp(H)
21 disp("m")
```

Scilab code Exa 8.6 6

```
1  clc;
2  Q=15/3600; // m^3/s
3  d=0.05; // m
4  Rho=780;
```

```

5 u=1.7*10^(-3); // Ns/m^2
6 f=0.0065;
7 L=100; // m
8 g=9.8; // m^2/s
9
10 v=4*Q/%pi/d^2;
11
12 del_pf=2*f*Rho*v^2*L/d;
13 disp("The pressure drop due to friction is ")
14 disp(del_pf);
15 disp("kNm-2")
16
17 H_f=4*f*L*v^2/(d*2*g);
18 H_exit=v^2/2/g;
19 H_entrance=v^2/4/g;
20
21 H=H_f+H_exit+H_entrance;
22 disp("and the difference in levels is")
23 disp(H);
24 disp("m");

```

Scilab code Exa 8.7 7

```

1 clc
2 f=0.005;
3 L=10; // m
4 d=0.025; // m
5 g=9.81; // m/s^2
6
7 // H_L=4*f*L/d*v^2/2/g+0.5*v^2/2/g
8 // H_L=8.5*v^2/2/g
9
10 // By Bernoulli equation we get
11 // H=2.62+9.5*v^2/2/g
12

```

```

13 // Applying the Bernoulli equation between the
    liquid surface and discharge point
14 //  $H_L = 33.5 * v_2^2 / 2 / g$ 
15
16 // Solving above two we get
17  $v_2 = 1.9$ ; // m/s
18
19  $Q = \pi * d^2 / 4 * v_2$ ;
20 disp("Rate of flow =")
21 disp(Q)
22 disp("m^3/s")
23
24  $H = 2.62 + 9.5 * v_2^2 / 2 / g$ ;
25 disp("The minimum allowable height =")
26 disp(H)
27 disp("m")

```

Scilab code Exa 8.8 8

```

1 clc;
2 d_A=0.025; // m
3 v_A=1.21; // m/s
4 d_B=0.05; // m
5 v_B=1.71; // m/s
6
7 Q_A=%pi*d_A^2*v_A/4;
8 disp("The rate of flow through parallel pipes A is ")
    )
9 disp(Q_A);
10 disp("m^3/s")
11
12 Q_B=%pi*d_B^2*v_B/4;
13 disp("The rate of flow through parallel pipes B is ")
    )
14 disp(Q_B);

```

```
15 disp("m^3/s")
```

Scilab code Exa 8.9 9

```
1 clc
2 d2=0.06; // m
3 d1=0.12; // m
4 k=0.44;
5 f=0.05;
6 L1=500; // m
7 g=9.81; // m/s^2
8
9 // v1=d2^2/d1^2*v2
10
11 // H_f=4*f*L1/16/d*v2^2/2/g
12 // H_c=k*v2^2/2/g
13 // H_f=4*f*L2/d*v2^2/2/g
14 // H_exit=v2^2/2/g
15
16 v2=sqrt(30*2*g/173.4);
17
18 Q=%pi*d2^2/4*v2;
19 disp("The rate of flow =")
20 disp(Q)
21 disp("m^3/s")
```

Scilab code Exa 8.10 10

```
1 clc
2 m=12*10^3/3600; // kg/s
3 Rho=815; // kg/m^3
4 d=0.05; // m
5 e=0.02;
```

```

6 d1=50; // m
7 d2=0.038; // m
8 g=9.8; // m
9
10 v=4*m/Rho/%pi/d^2;
11
12 f1=1/(2*log10(d1/e)+2.28)^2;
13
14 L_eq=d1+2*d1*d;
15
16 H_50mm=4*f1*L_eq*v^2/(d*2*g);
17
18 v=4*m/(Rho*%pi*d2^2);
19
20 f2=1/(2*log10(38/e)+2.28)^2;
21
22 L_eq=d1+2*d1*d2;
23 H_38mm=4*f2*L_eq*v^2/(d2*2*g);
24
25 Hr=0.2*v^2/(2*g);
26
27 H_L=H_50mm+H_38mm+Hr;
28
29 del_p_f=Rho*g*H_L;
30 disp("The total pressure drop due to friction
      through the pipe system is ")
31 disp(del_p_f);
32 disp("N/m^2")

```

Scilab code Exa 8.11 11

```

1 clc
2 // H.L=1.2*v^2/2/g
3
4 // H.L=4*f*L_eq/d*V^2/2/g

```

```

5
6 // L_eq=60*d
7
8 // H.L=240*f*v^2/2/g
9 // Combining the two equations for head loss
10 // 1.2*v^2/2/g=240*f*v^2/2/g
11
12 f=1.2/240;
13 disp(" Friction factor =")
14 disp(f)

```

Scilab code Exa 8.12 12

```

1 clc
2 // dp_AB+dp_BC=dp_AD+dp_DC
3
4 // dp_AD=2*f*rho*v^2*L/d
5
6 // dp_AD=16600*(3-Q)^2
7 // Likewise
8 // dp_AB=16600*Q^2
9 // dp_BC=16600*(Q+0.5)^2
10 // dp_DC=16600*(2.1-Q)^2
11 // By solving above 5 equations , we get
12
13 Q=1.175; //litres per second
14
15 disp("The rate of flow from B to C =")
16 disp(Q+0.5)
17 disp(" litres per second")
18
19 dp_AD=16600*(3-Q)^2;
20 dp_AB=16600*Q^2;
21 dp_BC=16600*(Q+0.5)^2;
22 dp_DC=16600*(2.1-Q)^2;

```

```

23
24 disp(" dp_AD =")
25 disp(dp_AD/1000)
26 disp(" kN/m^2")
27
28 disp(" dp_AB =")
29 disp(dp_AB/1000)
30 disp(" kN/m^2")
31
32 disp(" dp_BC =")
33 disp(dp_BC/1000)
34 disp(" kN/m^2")
35
36 disp(" dp_DC =")
37 disp(dp_DC/1000)
38 disp(" kN/m^2")
39
40
41 disp("The lowest pressure drop is in the pipe
      connecting C and D")

```

Scilab code Exa 8.13 13

```

1  clc
2  H2=0.5; //m
3  H1=2; //m
4  A=4; //m^2
5  f=0.005;
6  L=20; //m
7  d=0.025; //m
8  g=9.81; // m/s^2
9
10 a=%pi*d^2/4;
11
12 t=integrate('-A*sqrt((4*f*L/d)+2.5)/a/(sqrt(2*g))*(H

```

```

    )^(-1/2)', 'H', H1, H2);
13 disp("Time taken =")
14 disp(t)
15 disp("s")

```

Scilab code Exa 8.14 14

```

1  clc
2
3  d0=0.15; // m
4  d1=0.1; // m
5  Q=50/3600; // m^3/s
6  f=0.0052;
7  Rho=972;
8
9  a=%pi/4*((d0)^2-(d1)^2);
10
11 P=%pi*((d0)+(d1));
12
13 d_eq=4*a/P;
14
15 v=Q/a;
16
17 del_p_f=2*f*Rho*v^2/d_eq;
18 disp("the pressure drop due to friction per metre
    length of tube is found to be ")
19 disp(del_p_f)
20 disp("Nm^2/m")

```

Scilab code Exa 8.15 15

```

1  clc
2  f=0.005;

```

```

3 Q=0.07; // m^3/s
4 g=9.81; // m/s^2
5
6 H_f=integrate('32*f*(Q)^(2)/(%pi)^(2)/g/(0.3-0.0666*
    L)^(5)', 'L', 0, 3);
7 disp("Fractional head loss =")
8 disp(H_f)
9 disp("m")

```

Scilab code Exa 8.16 16

```

1 clc
2 g=9.81; // m/s^2
3 H=4; // m
4 f=0.006;
5 L=50; // m
6 d=0.1; // m
7
8 v1=sqrt(2*g*H/(4*f*L/d + 1.3));
9
10 t=integrate('4/(v1^2-v^2)', 'v', 0, 0.99*v1);
11 disp("Time taken =")
12 disp(t)
13 disp("s")

```

Chapter 9

Pumps

Scilab code Exa 9.2 2

```
1  clc
2  d=0.1; // m
3  v_r=2; // m/s
4  f=0.005;
5  g=9.81; // m/s^2
6  L_s=2; // m
7  L_r=10; // m
8  Q1=1.1*10^(-2); // m^3/s
9  z_t=12; // m
10 z_s=5; // m
11 L1=20; // m
12
13 Q=%pi*d^2/4*v_r;
14 H=12-70*Q-4300*Q^2;
15 k=2*g*H/v_r^2 - (4*f*(L_s+L_r)/d) - 1;
16 disp("The head loss across the restriction orifice =
    ")
17 disp(k)
18 disp("velocity heads")
19
20 // For the case of the valve being fully open
```

```

21 v_t=4*Q1/%pi/d^2;
22 v_r=((2*g*(z_t-z_s) + (4*f*L1/d + 1)*v_t^2)/(4*f*L_r
    /d + k + 1))^(1/2);
23
24 H1=4*f*L_r/d*v_r^2/2/g + 4*f*L_s/d*(v_r^2+v_t^2)/2/g
    + k*v_r^2/2/g + v_r^2/2/g;
25
26 Q=%pi*d^2/4*(v_t+v_r);
27
28 H2=12-70*Q-4300*Q^2;
29
30 disp("System head =")
31 disp(H1)
32 disp("m")
33
34 disp("Delivered head =")
35 disp(H2)
36 disp("m")
37
38 disp("The delivered head therefore closely matches
    the system head at the flow rate of 1.1*10^(-2) m
    ^3/s, corresponding to the duty point")

```

Scilab code Exa 9.6 6

```

1  clc
2  NPSH=5; // m
3  p_v=18*10^3; // N/m^2
4  p_l=0.94*101.3*10^3; // N/m^2
5  rho=970; // kg/m^3
6  g=9.81; // m/s^2
7  z_s=3; // m
8  H_L=0.5; // m
9  d=3; // m
10 h=2.5; // m

```

```

11 Q=5; // m^3/h
12
13 z1=NPSH+(p_v-p_l)/rho/g + z_s + H_L;
14 V=%pi/4*d^2*(h-z1);
15 t=V/Q;
16
17 disp("Quantity of liquid delivered =")
18 disp(V)
19 disp("m^3")
20
21 disp("Time taken =")
22 disp(t)
23 disp("h")

```

Scilab code Exa 9.8 8

```

1 clc
2 N_s=0.14; // m^(3/4)s^(-3/2)
3 H=30; // m
4 p_v=7.38*10^3; // N/m^2
5 p_l=50*10^3; // N/m^2
6 rho=992; // kg/m^3
7 g=9.81; // m/s^2
8 H_L=0.2; // m
9
10 NPSH=2.8*N_s^(4/3)*H;
11 z1=NPSH+(p_v-p_l)/rho/g+H_L;
12 disp("The minimum level of the alarm =")
13 disp(z1)
14 disp("m")

```

Scilab code Exa 9.10 10

```

1  clc
2  dz=10; // z2-z1
3  g=9.81; // m/s^2
4  d=0.05; // m
5  f=0.005;
6  L=100; // m
7  N1=1200; // rpm
8
9  // H=z2-z1+16*Q^2/2/g/%pi^2/d^4*(4*f*L/d+1)
10 // H=10+5.42*10^5*Q^2
11
12 Q=[0.000 0.002 0.004 0.006 0.008 0.010];
13 H_p=[40.0 39.5 38.0 35.0 30.0 20.0];
14 H_s=[10.0 12.2 18.7 29.5 44.7 64.2];
15
16 plot(Q,H_p, 'b')
17 plot(Q,H_s, 'r')
18 xtitle("", "Flow", "Head")
19 legend("pump", "system")
20
21 a=[0.0066 0.0066];
22 b=[0 33.8];
23 plot(a,b, '—')
24 e=[0 0.0066];
25 f=[33.8 33.8];
26 plot(e,f, '—')
27
28 i=[0.0049 0.0049];
29 h=[0 23];
30 plot(i,h, '—')
31 l=[0 0.00495];
32 m=[23 23];
33 plot(l,m, '—')
34
35 // From graph
36 H1=34; // m
37 H2=23; // m
38 Q1=0.0066; // m^3/s

```

```

39 Q2=0.00495; // m^3/s
40
41 disp("Duty point =")
42 disp(Q1)
43 disp("m^3/s")
44
45 N2=N1*(H2/H1)^(1/2);
46 disp("The speed of the pump to reduce the flow by 25
    % =")
47 disp(N2)
48 disp("rpm")

```

Scilab code Exa 9.11 11

```

1  clc
2  Q=0.05; // m^3/s
3  v=2; // m/s
4  f=0.005;
5  L_s=5; // m
6  d=0.178; // m
7  g=9.81; // m/s^2
8  L_d=20; // m
9  p2=1.5*10^5; // N/m^2
10 p1=0.5*10^5; // N/m^2
11 rho=1000; //kg/m^3
12 z2=15; // m
13 z1=5; // m
14 N1=1500/60; // rps
15
16
17
18
19 d=(4*Q/%pi/v)^(1/2);
20 H_f_s=4*f*L_s/d*v^2/2/g;
21 H_f_d=4*f*L_d/d*v^2/2/g;

```

```

22
23 H=1/(1-0.25)*((p2-p1)/rho/g + v^2/2/g + z2 - z1 +
    H_f_s + H_f_d);
24
25 // n=rho*g*Q*H/P
26
27 Q=[0 5 10 15 20 25];
28 H=[9.25 8.81 7.85 6.48 4.81 2.96];
29 P=[- 0.96 1.03 1.19 1.26 1.45];
30 n=[0 45 75 800 75 50];
31
32 H=27.96; // m
33 H1=6.48; // m
34 Q1=0.015; // m^3/s
35 Q=0.05; // m^3/s
36 D1=0.15; // m
37 n=0.80;
38
39 disp(" Differential Head =")
40 disp(H)
41 disp("m")
42
43 N=N1*(H/H1)^(3/4)*(Q1/Q)^(1/2);
44
45 D=D1*(Q*N1/Q1/N)^(1/5);
46 disp("The impeller diameter =")
47 disp(D)
48 disp("m")
49
50 disp("The rotational speed at maximum efficiency =")
51 disp(N)
52 disp(" rps")
53
54 P=rho*g*Q*H/n;
55 disp("Power input to the pump =")
56 disp(P)
57 disp("W")
58

```

```
59 N_s=N1*Q1^(1/2)/H1^(3/4);
```

Scilab code Exa 9.12 12

```
1 clc
2 N=2000/60; // rps
3 Q=50/3600; // m^3/s
4 g=9.81; // m/s^2
5 H=5; // m
6
7 S_n=N*Q^(1/2)/(g*H)^(3/4);
8 disp("Suction specific speed =")
9 disp(S_n)
```

Scilab code Exa 9.14 14

```
1 clc
2 A=0.01; // m^2
3 L=0.3; // m
4 N=60/60; // rps
5 V_act=10.6/3600; // m^3/s
6 rho=1000; // kg/m^3
7 g=9.81; // m/s^2
8 Q=10.6/3600; // m^3/s
9 H=15; // m
10
11 V=A*L*N;
12
13 Cd=V_act/V;
14 disp("Coefficient of discharge =")
15 disp(Cd)
16
17 P=rho*g*Q*H;
```

```
18 disp("The power required =")
19 disp(P)
20 disp("W")
```

Scilab code Exa 9.15 15

```
1  clc
2  // x=r*(1-cos(wt))
3  // v=r*w*sin(wt)
4  // V=2*A*w*r
5  // Q=V/2/%pi
6  // Q=A*w*r/%pi
7
8  // Q-peak=A*w*r
9
10 // Q-peak/Q=%pi
11
12 disp("The ratio of peak to average flow =")
13 disp(%pi)
```
