Scilab Textbook Companion for
Introductory Fluid Mechanics
by J. Katz[1]

Created by
Varalaxmi Boge
B.Com
Others
Samatha Degree College, Hyderabad
College Teacher
None
Cross-Checked by
Spandana

June 2, 2016

Book Description

Title: Introductory Fluid Mechanics

Author: J. Katz

Publisher: Cambridge University Press, Newyork

Edition: 1

Year: 2010

ISBN: 1107617138

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

List of Figures

Chapter 1

Basic Concepts and Fluid Properties

Scilab code Exa 1.1 Chapter1 Example1

```
1  clc
2  //initialization of new variables
3  clear
4  M=29 // Molecular weight of air
5  R=8314.3 // J/mol K  Gas constant
6  T=300 //K  Temperature
7  P=1 //kg/cm^2  Pressure
8  g=9.8 //m/s^2  Acceleration due to gravity
9  //calculations
10 R=R/M
11 P=P*g*10^4
12 rho=P/(R*T)
13 //result
14 printf(' Density = %.3f kg/m^3 ',rho)
```

Scilab code Exa 1.2 Chapter1 Example2

```
1  clc
2  //initialization of new variables
3  clear
4  t=2 //cm   thickness
5  U=3 //m/s    Velocity
6  mu=0.29 //kg/m s    Coefficient of Viscocity
7  //calculations
8  tau=mu*U/(t*10^-2)
9  //results
10 printf(' Shear = %d N/m^2',tau)
```

Scilab code Exa 1.4 Chapter1 Example4

```
1  clc
2  //initialization of new variables
3  clear
4  sigma=2.5*10^-2 //N/m
5  D=10 //cm
6  //calculations
7  R=D/2
8  dP=2*sigma/(R*10^-2)
9  //result
10 printf('The pressure difference is = %.1f N/m^2',dP)
```

Scilab code Exa 1.5 Chapter1 Example5

```
1  clc
2  //initialization of new variables
3  clear
4  R=1 //mm
5  sigma=0.073 //N/m
6  theta=0 //degrees
7  rho=1000 //kg/m^3
```

```
 8  g=9.8  //m/s^2
 9  //calculations
10  theta=theta*%pi/180  //radians
11  h=2*sigma*cos(theta)/(rho*g*R*10^-3)
12  //result
13  printf('The rise of water = %.3f m',h)
14  R=1  //mm
15  sigma=0.48  //N/m
16  theta=130  //degrees
17  rho=13600  //kg/m^3
18  g=9.8  //m/s^2
19  //calculations
20  theta=theta*%pi/180  //radians
21  h=2*sigma*cos(theta)/(rho*g*R*10^-3)
22  //result
23  printf('\n The rise of mercury = %.4f m',h)
```

Scilab code Exa 1.6 Chapter1 Example6

```
 1  clc
 2  //initialization of new variables
 3  clear
 4  E=2.34*10^9  //N/m^2   Modulus of Elasticity
 5  d=1  //km      depth
 6  rho=1000  //kg/m^3    density
 7  g=9.8  //m/s^2     Acceleration due to gravity
 8  //calculations
 9  d=d*1000
10  dp=rho*g*d
11  dVV=dp/E
12  //result
13  printf('The change in pressure is %.2e N/m^2 ',dp)
14  printf('\n Change in volume is %.3e ',dVV)
```

Scilab code Exa 1.7 Chapter1 Example7

```
1  clc
2  //initialization of new variables
3  clear
4  T=300  //K
5  gama=1.4
6  R=286.6
7  //calculation
8  // for air
9  a=sqrt(gama*R*T)
10 //result
11 printf('The speed of sound in air is %.1f m/s ',a)
12 // for sea water
13 E=2.34*10^9 // N/m^2
14 rho=1000 //kg/cm^2
15 a=sqrt(E/rho)
16 //result
17 printf(' \n The speed of sound in sea waer is %d m/s
        ',a)
```

Chapter 2

The Fluid Dynamic Eqaution

Scilab code Exa 2.3 Chapter2 Example3

```
1  clc
2  //initialization of new variables
3  clear
4  A1=30 //cm^2   Area at station 1
5  u1=1 //m/s      Velocity at station 1
6  A3=20 //cm^2   Area at station 3
7  u3=1.2 //m/s    Velocity at Station 3
8  A2=20 //cm^2     Area at station 2
9  rho=1000 //kg/m^3  density
10 // Calculations
11 // m stands for mass flow rate which is conserved
12 m1=rho*u1*A1*10^-4
13 m3=rho*u3*A3*10^-4
14 m2=m1-m3
15 u2=m2/(rho*A2*10^-4)
16 //result
17 printf('Mass flow rate entering station 1 is %.1f kg
       /s',m1)
18 printf('\n Mass flow rate entering station 2 is %.1f
        kg/s',m2)
19 printf('\n The average velocity leaving at station 2
```

```
is %.1 f m/s ',u2)
```

Scilab code Exa 2.4 Chapter2 Example4

```
1  clc
2  // initialization  of  new  variables
3  clear
4  Ue =5  //m/s   Velocity
5  Ae =20  //cm^2   Area
6  dp =0     // Pressure  difference
7  rho =1000  //kg/m^3     density
8  // calculations
9  Ae = Ae *10^ -4
10  Fx = rho * Ue ^2* Ae
11  // result
12  printf ( 'The  force  on  the  water  pipe  is  %d N ',Fx)
```

Chapter 3

Fluid Statics

Scilab code Exa 3.1 Chapter3 Example1

```
1  clc
2  //initialization of new variables
3  clear
4  h=380 //m
5  T=300 //K
6  g=9.81 //m/s^2
7  R=286.6  //m2/(s^2 K)
8  //calculations
9  Pr=exp(-g*h/(R*T)) //P2/P1
10 P1=1  //atm
11 dP=(P1-Pr)*101325 //N/m^2
12 //result
13 printf('The difference in pressure is %d N/m^2',dP)
```

Scilab code Exa 3.2 Chapter3 Example2

```
1  clc
2  //initialization of new variables
```

```
 3  clear
 4  d=4 //m  Diameter
 5  h=10 //m  depth
 6  th=60 //degrees  Wall inclination
 7  rho=1000 //kg/m^3  density
 8  g=9.8 //m/s^2  Accelaration due to gravity
 9  //calculations
10  p=rho*g*h
11  th=th*%pi/180
12  R=d/2
13  S=%pi*R^2
14  Fz=-p*S
15  Y=%pi*R^4/(4*h*%pi*R^2/sin(th))
16  M=Fz*Y
17  //result
18  printf('Hydrostatic force = %.2e N',Fz)
19  printf('\n Y coordinate of center of pressure with
        respect to centroid is %.4f m',Y)
20  printf('\n The moment required to open it is %.2e Nm
        ',-M)
```

Scilab code Exa 3.3 Chapter3 Example3

```
 1  clc
 2  //initialization of new variables
 3  clear
 4  d=5 //m  depth
 5  h=11 //m    where traingle base is located
 6  rho=1000 //kg/m^3  density
 7  g=9.8 //m/s^2  Acceleration due to gravity
 8  s=6 //m  from figure
 9  theta=30 //degrees
10  k=8 //m from the figure
11  kk=4 //m  from the figure
12  b=6 //m from the figure
```

15

```
13  //calculations
14  theta=theta*%pi/180
15  h_bar=d+k*sin(theta)
16  p=rho*g*h_bar
17  S=0.5*b*(kk+k)
18  Fz=-p*S
19  Ixx=b*(kk+k)^3/36
20  Ixy=b*(b-2*s)*(kk+k)^2/72
21  y_bar=h_bar/sin(theta)
22  X=Ixy/(y_bar*S)
23  Y=Ixx/(y_bar*S)
24  //results
25  printf('Force = %.3e N',Fz)
26  printf('\n coordinates of center of pressure
        relative to centroid are \n (X, Y) = (%.3f, %.3f)
        m',X,Y)
```

Scilab code Exa 3.4 Chapter3 Example4

```
1  clc
2  //initialization of new variables
3  clear
4  F=20.9 //N
5  Vc=310 //cm^3
6  rho_w=1000 //kg/m^3
7  g=9.8 //m/s^2
8  //calculations
9  Wc=F+rho_w*g*Vc*10^-6
10 rho_c=Wc/(Vc*10^-6*g)
11 //result
12 printf('The crown density is %d kg/m^3',rho_c)
```

Scilab code Exa 3.5 Chapter3 Example5

```
 1  clc
 2  //initialization of new variables
 3  clear
 4  W=275  //kg
 5  rho_c=1.22  //kg/m^3
 6  D=15  //m
 7  g=9.8  //m/s^2
 8  Tc=290  //K
 9  //calculations
10  L=W*g
11  Tr=1-(6*L/(rho_c*g*%pi*D^3))   // Tc/Th
12  Th=Tc/Tr
13  //result
14  printf('The temperature required is % .1f K',Th)
```

Chapter 4

Introduction to Fluid in Motion

Scilab code Exa 4.1 Chapter4 Example1

```
 1  clc
 2  //initialization of new variables
 3  clear
 4  An=1 //cm^2
 5  Un=15 //m/s
 6  Ub=10 //m/s
 7  U1=5 //m/s
 8  U2=5 //m/s
 9  th=120 //degrees
10  rho=1000 //kg/m^3
11  //calculations
12  th=th*%pi/180
13  Fx=rho*U1^2*An*10^-4*(cos(th)-1)
14  Fz=rho*U1^2*An*10^-4*sin(th)
15  W=Fx*Ub
16  //results
17  printf('The forces acting are Fx = %.2f N \n Fz = %
        .2f N ',Fx,Fz)
18  printf('\n The power generated is %.1f W',-W)
```

Scilab code Exa 4.2 Chapter4 Example2

```
1  clc
2  // initialization of new variables
3  clear
4  u=15  //m/s
5  D=0.1  //m
6  u1=10  //m/s
7  u2=10  //m/s
8  rho=1000  //kg/m^3
9  th=60  // degrees
10 // calculations
11 th=th*%pi/180
12 A=%pi*D^2/4
13 Fx=rho*u^2*A*(cos(th)-1)
14 // result
15 printf('Force on the wedge is  Fx = %.1f N',Fx)
16 printf('\n Fz = 0 N')
```

Scilab code Exa 4.7 Chapter4 Example7

```
1  clc
2  // initialization of new variables
3  clear
4  m=1  //kg
5  p=10^5  //N/m^2
6  A=1  //cm^2
7  w=0.5  //kg
8  rho=1000  //kg/m^2
9  // calculations
10 Ue=sqrt(2*p/rho)
11 m_0=w+m
```

```
12  m_s=w
13  Uf=Ue*log(m_0/m_s)
14  //results
15  printf('The exit velocity is %.2f m/s',Ue)
16  printf('\n The final velocity of the system is %.2f
        m/s ',Uf)
```

Scilab code Exa 4.8 Chapter4 Example8

```
1  clc
2  //initialization of new variables
3  clear
4  h=20  //cm
5  g=9.8  //m/s^2
6  rho_w=1000  //kg/m^3
7  rho_a=1.2  //kg/m^3
8  //calculations
9  dP=rho_w*g*h*10^-2
10 U=sqrt(2*dP/rho_a)
11 //results
12 printf('Air speed is %.2f m/s ',U)
```

Chapter 5

Viscous Incompressible Flow Exact Solutions

Scilab code Exa 5.2 Chapter5 Example2

```scilab
1  clc
2  //initialization of new variables
3  clear
4  U=5 //m/s
5  h=1 //cm
6  mu=0.001
7  //calculations
8  Uav=U/2
9  Q=U*h*10^-2/2
10 tau_xz=mu*U/(h*10^-2)
11 S=1 //m^2
12 F=tau_xz*S
13 //results
14 printf('Shear stress per unit width at wall is %.1f
       N/m^2',tau_xz)
15 printf('\n The force required is %.1f N',F)
```

Scilab code Exa 5.3 Chapter5 Example3

```
1  clc
2  //initialization of new variables
3  clear
4  Uav=1 //m/s
5  h=1 //cm
6  mu=0.001
7  rho=1000 //kg/m^3
8  //calculations
9  h=h*10^-2
10 Umax=1.5*Uav
11 Dp=-12*mu*Uav/h^2
12 tau=-h/2*Dp
13 Re=rho*Uav*h/mu
14 Cf=12/Re
15 //results
16 printf('Max velocity = %.2f m/s ',Umax)
17 printf('\n Pressure gradient = %.2f N/m^3',Dp)
18 printf('\n shear = %.1f N',tau)
19 printf('\n friction coefficient = %.2e ',Cf)
```

Scilab code Exa 5.4 Chapter5 Example4

```
1  clc
2  //initialization of new variables
3  clear
4  h1=0.2 //mm gap
5  hr=2.2   //gap ratio
6  u=50 //m/s   linear velocity
7  mu=1.8*10^-5 // Coefficient of Viscocity
8  l=1 //cm   Length of the magnetic pickup
9  //calculations
10 l=l*10^-2
11 h1=h1*10^-3
```

```
12  L=0.16*mu*u*(l/h1)^2
13  R=4.7*h1/l
14  //results
15  printf('Lift = %.2f N/m',L)
16  printf('\n Drag to Lift ratio = %.3f ',R)
```

Scilab code Exa 5.5 Chapter5 Example5

```
1   clc
2   //initialization of new variables
3   clear
4   L=3  //m
5   D=1.2  //cm
6   Q=0.5  //L/min
7   mu=1.9*10^-2
8   rho=814  //kg/m^3
9   //calculations
10  R=D/2*10^-2
11  Q=Q/60*10^-3
12  Dp=-Q*8*mu/(%pi*R^4)
13  S=%pi*R^2
14  Uav=Q/S
15  Re=rho*Uav*D/mu
16  //results
17  printf('The pressure drop is %.1f N/m^2',Dp)
18  // Answer given in the ext is wrong by a scale of 10
```

Scilab code Exa 5.6 Chapter5 Example6

```
1   clc
2   //initialization of new variables
3   clear
4   L=10  //m
```

```
 5  D=0.02  //m
 6  Uav=0.15  //m/s
 7  rho=1000  //kg/m^3
 8  mu=10^-3
 9  g=9.8  //m/s^2
10  //calculations
11  Re=rho*Uav*D/mu
12  f=64/Re
13  Hf=f*L*Uav^2/(D*2*g)
14  //results
15  printf('Head loss is = %.4f m',Hf)
```

Scilab code Exa 5.7 Chapter5 Example7

```
 1  clc
 2  //initialization of new variables
 3  clear
 4  Q=6  //L/min
 5  D=3  //cm
 6  K=0.32
 7  g=9.8  //m/s^2
 8  rho=1000  //kg/m^3
 9  //calculations
10  R=D/2*10^-2
11  S=%pi*R^2
12  Q=Q/60*10^-3
13  Uav=Q/S
14  Hf=K*Uav^2/(2*g)
15  dP=Hf*rho*g
16  //results
17  printf('The pressure drop is %.2f N/m^2',dP)
18  printf('\n Head loss is %.2e m',Hf)
```

Scilab code Exa 5.8 Chapter5 Example8

```
1  clc
2  //initialization of new variables
3  clear
4  h=20 //m
5  a=2 //m
6  f=0.015
7  D=0.3 //m
8  K=0.3
9  g=9.8 //m/s^2
10 rho=804 //kg/m^3
11 mu=1.9*10^-3 //N s/m^2
12 //calculations
13 u2=sqrt((h+a)*2*g/(1+f*202/D+2*K))
14 S=%pi*D^2/4
15 Q=u2*S
16 Re=rho*u2*D/mu
17 //results
18 printf('Average discarge velocity = %.2f m/s',u2)
19 printf('\n Re = %.3e ',Re)
```

Scilab code Exa 5.9 Chapter5 Example9

```
1  clc
2  //initialization of new variables
3  clear
4  h2=0.2 //m
5  D=0.01 //m
6  h1=0.1 //m
7  rho=1254 //kg/m^3
8  mu=0.62 //N s/m^2
9  g=9.8 //m/s^2
10 //calculations
11 // Quadratic equation: a*u^2+b*u+c=0
```

```
12  a=1/(2*g)
13  b=32*mu*h2/(rho*g*D^2)
14  c=-(h1+h2)
15  u2a=(-b+sqrt(b^2-4*a*c))/(2*a)
16  u2b=(-b-sqrt(b^2-4*a*c))/(2*a)
17  u2=max(u2a,u2b)
18  //results
19  printf('Exit velocity is %.3f m/s',u2)
20  // Answer in the text differs by a scale of 10
```

Scilab code Exa 5.10 Chapter5 Example10

```
 1  clc
 2  //initialization of new variables
 3  clear
 4  h=20  //m
 5  D1=0.3  //m upto 50 m distance
 6  D2=0.2  //m
 7  K=0.1
 8  L1=50  //m
 9  L2=100  //m
10  f=0.015
11  g=9.8  //m/s^2
12  //calculations
13  u3=sqrt(h*2*g/(1+f*L1/D1*(D2/D1)^4+K*(D2/D1)^4+f*L2/
        D2))
14  S3=%pi*D2^2/4
15  Q=u3*S3
16  //results
17  printf('Average discharge velocity is %.2f m/s',u3)
18  printf('\n The corresponding flow rate is %.2f m/s',
        Q)
```

Scilab code Exa 5.11 Chapter5 Example11

```
1  clc
2  //initialization of new variables
3  clear
4  L=20  //m
5  D=6  //cm
6  th=40  //degrees
7  Q=7.63  //L/s
8  rho=900  //kg/m^3
9  mu=0.18  //N s/m^2
10 g=9.8  //m/s^2
11 //calculations
12 th=th*%pi/180
13 R=D/2*10^-2
14 S=%pi*R^2
15 U=Q*10^-3/S
16 Re=rho*U*D*10^-2/mu
17 f=64/Re
18 Hf=f*L/D*U^2/(2*g)*10^2
19 Dp=rho*g*(L*sin(th)+Hf)
20 P=Dp*Q*10^-3
21 //result
22 printf('Power = %.1f W',P)
```

Scilab code Exa 5.12 Chapter5 Example12

```
1  clc
2  //initialization of new variables
3  clear
4  Q=5  //L/min
5  L=10  //m
6  D=5  //cm
7  UD=3  //cm
8  L1=12  //m
```

```
 9  K1 =0.9
10  K2 =0.2
11  f =0.025
12  // calculations
13  Q=Q *10^ -3
14  D=D *10^ -2
15  R=D/2
16  UD=UD *10^ -2
17  UR=UD/2
18  Ur=f*L/D/(f*L1/UD+2*K1+2*K2)
19  Ur=sqrt(Ur)
20  Ul=Q/%pi*1/(R^2+Ur*UR^2)
21  Ql=%pi*R^2*Ul*10^3
22  // results
23  printf('Velocity  and  flow  rate  in  the  lower  pipe  are
           respectively  %.2f  m/s  %.2f  L/s',Ul,Ql)
```

Scilab code Exa 5.13 Chapter5 Example13

```
 1  clc
 2  // initialization  of  new  variables
 3  clear
 4  z=0.8  //m
 5  b=1  //m
 6  th=60  // degrees
 7  n=0.012
 8  phi=0.3  // degrees
 9  // calculations
10  th=th*%pi/180
11  phi=phi*%pi/180
12  S=(1+z/tan(th))*z
13  Ph=1+2*z/sin(th)
14  Rh=S/Ph
15  Uav=1/n*Rh^(2/3)*sqrt(tan(phi))
16  Q=Uav*S
```
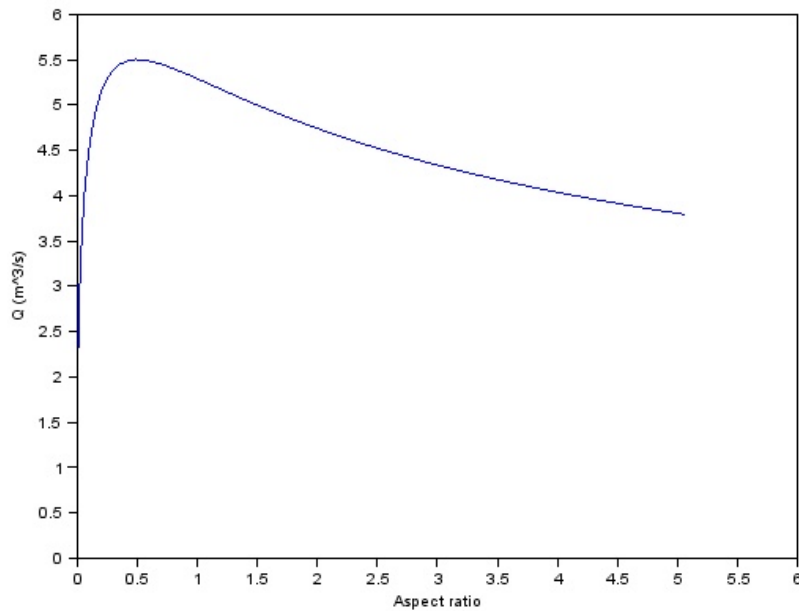
Figure 5.1: Chapter5 Example14

```
17  //results
18  printf('Average velocity is %.2f m/s',Uav)
19  printf('\n Flow rate = %.2f m^3/s',Q)
```

Scilab code Exa 5.14 Chapter5 Example14

```
1  clc
2  //initialization of new variables
3  clear
4  n = 0.012;
5  S = 1;
```

```
6  alpha = 1;//degrees
7  Z = 0.00005:0.05:5;
8  k = (5-0.00005)/0.05 +1;
9  for i = 1:k
10     R_h(i) = S/((1/Z(i))+2*Z(i));
11     U_av(i) = (1/n)*(R_h(i)^(2/3))*sqrt(tan(alpha*
           %pi/180));
12     Q(i) = U_av(i)*S;
13     b(i) = S/Z(i);
14     AR(i) = Z(i)/b(i);
15 end
16
17 plot(AR(1:46),U_av(1:46));
18 xlabel('Aspect ratio');
19 ylabel('Q (m^3/s)');
```

Scilab code Exa 5.15 Chapter5 Example15

```
1  clc
2  //initialization of new variables
3  clear
4  D=1  //m
5  alpha=0.5  //degrees
6  n=0.012
7  //calculations
8  R=D/2
9
10
11 theta = 1:1:180;
12 R_h = 0.5*R - (45*R/%pi)*(sin(2*theta*%pi/180))./(
       theta*180/%pi);
13 Z = R*(1-cos(theta*%pi/180));
14 U_av = (1/n)*(R_h^(2/3))*sqrt(tan(alpha));
```
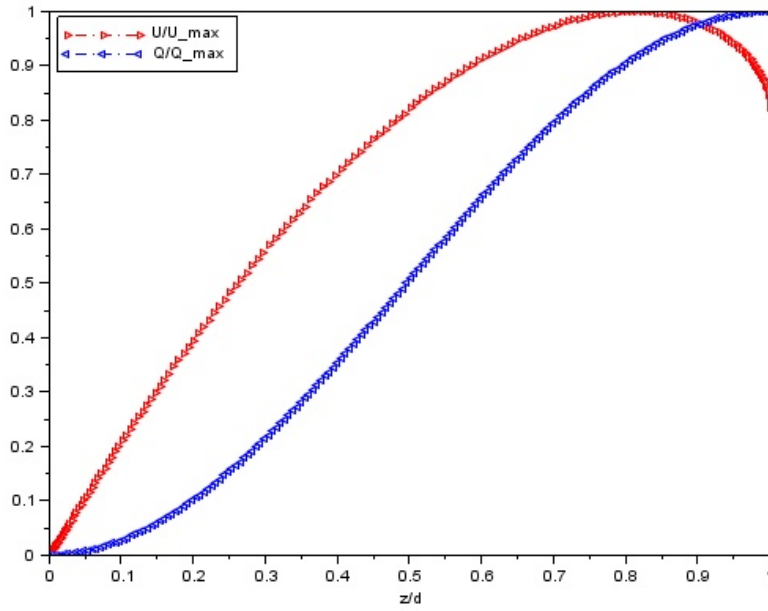
Figure 5.2: Chapter5 Example15

```
15  Q = U_av*%pi*R^2 .*(theta*180/%pi) - (0.5*R^2)*sin
       (2*theta*%pi/180);
16
17  plot(Z/D,(U_av-U_av(1))/max(U_av-U_av(1)),'r>-.');
18  //ylabel('U/U_max');
19  plot((Q-Q(1))/max(Q-Q(1)),Z/D,'b<-.');
20  //ylabel('Q/Q_max');
21  xlabel('z/d');
22  legend(['U/U_max"; 'Q/Q_max';],opt=2);
```

Scilab code Exa 5.16 Chapter5 Example16

```
1  clc
2  //initialization of new variables
3  clear
4  u1=8  //m/s
5  z1=1  //m
6  g=9.8  //m/s^2
7  //calculations
8  Fr1=u1/sqrt(g*z1)
9  zr=(-1+sqrt(1+8*Fr1^2))/2
10  z2=z1*zr
11  u2=u1*z1/z2
12  Fr2=u2/sqrt(g*z2)
13  hr=1-zr+u1^2/(2*g*z1)-u2^2/(2*g*z1)
14  loss=hr*z1/(z1+u1^2/(2*g))
15  //results
16  printf('Fr1 = %.3f',Fr1)
17  printf('\n Fr2 = %.3f',Fr2)
18  printf('\n percent of loss = %.1f percent',loss*100)
```

Scilab code Exa 5.17 Chapter5 Example17

```
 1  clc
 2  //initialization of new variables
 3  clear
 4  D=0.5  //m
 5  H=0.5  //m
 6  d=1  //m
 7  g=9.8  //m/s^2
 8  //calculations
 9  Cd=0.399+0.0598*H/D
10  Q=Cd*d/2*sqrt(2*g)*H^(3/2)
11  //results
12  printf('Flow rate is Q = %.3f m^3/s',Q)
```

Chapter 7

The Laminar Boundary Layer

Scilab code Exa 7.1 Chapter7 Example1

```
1  clc
2  //initialization of new variables
3  clear
4  w=1  //m
5  L=0.5  //m
6  u=2  //m/s
7  rho=1000  //kg/m^3
8  mu=10^-3
9  //calculations
10 ReL=rho*u*L/mu
11 Cd=2*0.664/sqrt(ReL)
12 D=2*Cd*1/2*rho*u^2*(w*L)
13 del=1.721*L/sqrt(ReL)
14 th=0.664*L/sqrt(ReL)
15 //results
16 printf('The drag on teh plate is %.3f N',D)
```

Scilab code Exa 7.2 Chapter7 Example2

```
 1  clc
 2  //initialization of new variables
 3  clear
 4  u=12 //m/s
 5  w=10 //m
 6  L=4 //m
 7  rho=1.22 //kg/m^3
 8  mu=1.8*10^-5
 9  //calculations
10  ReL=rho*u*L/mu
11  Cd=0.0032 //from figure
12  D=2*Cd*1/2*rho*u^2*(w*L)
13  //results
14  printf('Total drag on plates is %.2f N',D)
```

Chapter 8

High Reynolds Number Flow Over Bodies

Scilab code Exa 8.1 Chapter8 Example1

```
1 clc
2 //initialization of new variables
3 clear
4 sigma=5 //m^2/s
5 x0=1
6 y0=1 //(x0,y0) location of source
7 x=0
8 y=-1
9 //calculations
10 u=sigma/(2*%pi)*(x-x0)/((x-x0)^2+(y-y0)^2)
11 w=sigma/(2*%pi)*(y-y0)/((x-x0)^2+(y-y0)^2)
12 //results
13 printf('u = %.3f m/s',u)
14 printf('\n w = %.3f m/s',w)
```

Scilab code Exa 8.2 Chapter8 Example2

```
1   clc
2   //initialization of new variables
3   clear
4   mu=1  //m^3/s
5   x0=0
6   z0=0
7   x=1
8   z=0
9   //calculations
10  u=mu/(2*%pi)*((x-x0)^2-(z-z0)^2)/((x-x0)^2+(z-z0)^2)
      ^2
11  w=mu/(2*%pi)*2*(x-x0)*(z-z0)/((x-x0)^2+(z-z0)^2)^2
12  //results
13  printf('u = %.2f m/s',u)
14  printf('\n w = %.2f m/s',w)
```

Scilab code Exa 8.3 Chapter8 Example3

```
1   clc
2   //initialization of new variables
3   clear
4   gama=5  //m^2/s
5   x0=1
6   y0=1  //(x0,y0) location of source
7   x=0
8   y=-1
9   //calculations
10  w=-gama/(2*%pi)*(x-x0)/((x-x0)^2+(y-y0)^2)
11  u=gama/(2*%pi)*(y-y0)/((x-x0)^2+(y-y0)^2)
12  //results
13  printf('u = %.3f m/s',u)
14  printf('\n w = %.3f m/s',w)
15  x=3
16  y=0
17  //calculations
```

```
18  w=-gama/(2*%pi)*(x-x0)/((x-x0)^2+(y-y0)^2)
19  u=gama/(2*%pi)*(y-y0)/((x-x0)^2+(y-y0)^2)
20  //results
21  printf('\n for the second point')
22  printf('\n u = %.3f m/s',u)
23  printf('\n w = %.3f m/s',w)
```

Scilab code Exa 8.6 Chapter8 Example6

```
1  clc
2  //initialization of new variables
3  clear
4  Re=3*10^6
5  CdT=0.004
6  x=0.4  //40%
7  //calculations
8  Cd=2*0.664/sqrt(Re)
9  Cd=x*Cd+(1-x)*CdT
10 Cd=2*Cd
11 //results
12 printf('For two sides the drag coefficient is
       estimated as %.4f',Cd)
```

Scilab code Exa 8.7 Chapter8 Example7

```
1  clc
2  //initialization of new variables
3  clear
4  h=15  //m
5  D=0.25  //m
6  u=30  //m/s
7  rho=1.2  //kg/m^3
8  mu=1.81*10^-5
```

38

```
9   Cd=0.7
10  Re=rho*u*D/mu
11  D=Cd*1/2*rho*u^2*(h*D)
12  M=h/2*D
13  //results
14  printf('D = %.1f N',D)
15  printf('\n M = %d N m',M)
```

Scilab code Exa 8.8 Chapter8 Example8

```
1   clc
2   //initialization of new variables
3   clear
4   D=0.5  //cm
5   rAl=2700  //kg/m^3
6   mu=0.29
7   rOil=919  //kg/m^3
8   g=9.8  //m/s^2
9   //calculations
10  D=D*10^-2
11  R=D/2
12  U=2/(9*mu)*(rAl-rOil)*g*R^2
13  //result
14  printf('The ball will sink with %.3f m/s',U)
```

Scilab code Exa 8.9 Chapter8 Example9

```
1   clc
2   //initialization of new variables
3   clear
4   Cd=1.2
5   r=1.2  //kg/m^3
6   u=15  //km/h
```

```
 7 l=1 //m
 8 b=1 //m
 9 //calculations
10 D=Cd*1/2*r*(u/3.6)^2*(l*b)
11 //result
12 printf('The force on the plate is %.1f N',D)
```

Scilab code Exa 8.10 Chapter8 Example10

```
 1 clc
 2 //initialization of new variables
 3 clear
 4 u=25 //km/h
 5 t=1 //h
 6 S=0.36 //m^2
 7 Cd=0.88
 8 r=1.2 //kg/m^3
 9 //calculations
10 D=Cd*1/2*r*(u/3.6)^2*(S)
11 P=D*u/3.6
12 E=P*t*3600
13 //results
14 printf('Drag force = %.2f N',D)
15 printf('\n Power = %.2f W',P)
16 printf('\n Energy spent is %.1f KJ',E/1000)
```

Scilab code Exa 8.11 Chapter8 Example11

```
 1 clc
 2 //initialization of new variables
 3 clear
 4 u=20 //km/h
 5 Cd=0.15
```

```
 6 S=4 //m^2
 7 r=1025 //kg/m^3
 8 //calculations
 9 D=Cd*1/2*r*(u/3.6)^2*(S)
10 P=D*u/3.6
11 //results
12 printf('Drag force = %d N',D)
13 printf('\n Power = %.2f KW',P/1000)
```

Scilab code Exa 8.12 Chapter8 Example12

```
 1 clc
 2 //initialization of new variables
 3 clear
 4 m=90 //kg
 5 D=6 //m
 6 g=9.8 //m/s^2
 7 r=1.2 //kg/m^3
 8 Cd=1.2
 9 //calculations
10 R=D/2
11 S=%pi*R^2
12 U=sqrt(2*m*g/(Cd*r*S))
13 //results
14 printf('U = %.2f m/s',U)
```

Scilab code Exa 8.13 Chapter8 Example13

```
 1 clc
 2 //initialization of new variables
 3 clear
 4 Cd=0.32
 5 S=1.8 //m^2
```

```
6  Pe =300  //hp
7  u=100  //km/h
8  r =1.2  //kg/m^3
9  //calculations
10 D=Cd*1/2*r*(u/3.6)^2*(S)
11 P=D*u/3.6
12 //result
13 printf('Power required = %.1f kW = %.1f hp',P/1000,P
       *1.341/1000)
```

Scilab code Exa 8.14 Chapter8 Example14

```
1  clc
2  //initialization of new variables
3  clear
4  D=0.3  //m
5  u=35  //m/s
6  r =1.2  //kg/m^3
7  mu =1.81*10^-5
8  St =0.23
9  //calculations
10 Re=r*u*D/mu
11 f=St*u/D
12 //results
13 printf('So there are %d full cycles per second',f)
```

Scilab code Exa 8.15 Chapter8 Example15

```
1  clc
2  //initialization of new variables
3  clear
4  w=2  //m
5  u=100  //km/h
```

```
6  r =1.2  //kg/mˆ3
7  mu =1.81*10ˆ -5
8  // calculations
9  D=w
10  Re=r*u*D/(3.6* mu)
11  St =0.23  // based on Re
12  f =St*u/(3.6* D)
13  l=u/(3.6* f)
14  // results
15  printf ( 'Oscillation frequency is %.2 f Hz' ,f)
16  printf ( '\n The distance between two cycles is %.2 f m
       ' ,l)
```

Scilab code Exa 8.16 Chapter8 Example16

```
1  clc
2  // initialization of new variables
3  clear
4  D =0.65  //cm
5  u=50  //km/h
6  r =1.2  //kg/mˆ3
7  mu =1.81*10ˆ -5
8  // calculations
9  D=D*10ˆ -2
10  Re=r*u*D/(3.6* mu)
11  St =0.21  // based on Re
12  f =St*u/(3.6* D)
13  // results
14  printf ( 'So there are %d full cycles per second' ,f)
```

Scilab code Exa 8.17 Chapter8 Example17

```
1  clc
```

```
 2 //initialization of new variables
 3 clear
 4 D=3  //cm
 5 u=11  //m/s
 6 w=7000  //RPM
 7 r=1.2  //kg/m^3
 8 //calculations
 9 D=D*10^-2
10 R=D/2
11 S=%pi*R^2
12 Rw=R*2*%pi*w/60*1/u
13 Cl=0.27  //based on Rw
14 Cd=0.63  //based on Rw
15 L=Cl*0.5*r*u^2*S
16 D=Cd*0.5*r*u^2*S
17 //results
18 printf('Lift = %.3f N',L)
19 printf('\n Drag = %.3f N',D)
```

Scilab code Exa 8.18 Chapter8 Example18

```
 1 clc
 2 //initialization of new variables
 3 clear
 4 c=3.5  //m
 5 u=20  //km/h
 6 alpha=5  //degrees
 7 r=1.2  //kg/m^3
 8 //calculations
 9 alpha=alpha*%pi/180
10 Cl=2*%pi*alpha
11 L=0.5*Cl*r*(u/3.6)^2*c*1
12 //results
13 printf('Lift per unit span is %.2f N',L)
```

Scilab code Exa 8.19 Chapter8 Example19

```
1  clc
2  //initialization of new variables
3  clear
4  m=50  //kg
5  r=1.2  //kg/m^3
6  u=150  //km/h
7  Cl=0.5
8  g=9.8  //m/s^2
9  //calculations
10 c=m*g/(0.5*r*(u/3.6)^2*Cl)
11 Cd=0.005  //from figure
12 r=Cl/Cd
13 //results
14 printf('The chord length required is %.2f m',c)
15 printf('\n Lift to Drag ratio is %d',r)
```

Scilab code Exa 8.20 Chapter8 Example20

```
1  clc
2  //initialization of new variables
3  clear
4  c=3.5  //m
5  b=10  //m
6  u=20  //km/h
7  r=1.2  //kg/m^3
8  a=5  //degrees
9  //calculations
10 a=a*%pi/180
11 Cl=2*%pi*a/(1+2*c/b)
12 L=Cl*0.5*r*(u/3.6)^2*(c*b)
```

```
13  AR=b/c
14  Cdi=Cl^2/(%pi*AR)
15  Di=Cdi*0.5*r*(u/3.6)^2*(c*b)
16  //results
17  printf('Lift = %.2f N',L)
```

Scilab code Exa 8.21 Chapter8 Example21

```
1  clc
2  //initialization of new variables
3  clear
4  m=100  //tonne
5  u=200  //km/h
6  b=47  //m
7  r=1.22  //kg/m^3
8  g=9.8  //m/s^2
9  //calculations
10  gama=m*1000*g/(r*u/3.6*b)
11  w=2*gama/(%pi*b/2)
12  //results
13  printf('Downwash = %.2f m/s',w)
```

Scilab code Exa 8.22 Chapter8 Example22

```
1  clc
2  //initialization of new variables
3  clear
4  a=8  //degrees  In text calculated for 8 degrees even
        thoygh they mentioned it as 5 degrees
5  c=0.5  //m
6  b1=2  //m
7  b2=4  //m
8  //calculations
```

```
 9  a=a*%pi/180
10  AR1=b1/c
11  AR2=b2/c
12  Cla1=2*%pi/(1+b1/AR1)
13  Cla2=2*%pi/(1+b2/AR2)
14  Cl1=Cla1*a
15  Cl2=Cla2*a
16  Cd1=Cl1^2/(%pi*AR1)
17  Cd2=Cl2^2/(%pi*AR2)
18  r1=Cl1/Cd1
19  r2=Cl2/Cd2
20  //results
21  printf('Lift to induced drag ratios are respectively
        %.2f and %.2f ',r1,r2)
```

Scilab code Exa 8.23 Chapter8 Example23

```
 1  clc
 2  //initialization of new variables
 3  clear
 4  m=250  //tonne   Weight
 5  b=64.4  //m      wing span
 6  S=541  //m^2    Wing area
 7  c=8.4  //m      Wing chord
 8  r=1.1  //kg/m^3   Air density
 9  u=600  //km/h     air speed
10  g=9.8  //m/s^2   Acceleration due to gravity
11  //calculations
12  u=u/3.6
13  Cl=m*g*1000/(0.5*r*u^2*S)
14  AR=b^2/S
15  Cla=2*%pi/(1+2/AR)
16  aa=Cl/Cla
17  aa=aa*180/%pi
18  //results
```

```
19 printf('Airplane angle of attack is %.1f degrees',aa
      )
20 printf('\n Lift slope is %.2f ',Cla)
```

Scilab code Exa 8.24 Chapter8 Example24

```
1  clc
2  //initialization of new variables
3  clear
4  b=4 //m   wide
5  c=0.5 //m   chord
6  a=5 //degrees   angle of inclination
7  u=12 //m/s  speed
8  r=1030 //kg/m^3  density
9  //calculations
10 a=a*%pi/180
11 AR=b/c
12 Cla=2*%pi/(1+2/AR)
13 Cl=Cla*a
14 W=Cl*0.5*r*u^2*b
15 Cdi=Cl^2/(%pi*AR)
16 Di=0.5*Cdi*r*u^2*b
17 P=Di*u
18 printf('The power required is %.2f kW',P/1000)
19 printf('\n The weight of the boat is %.d N',W)
```

Scilab code Exa 8.25 Chapter8 Example25

```
1  clc
2  //initialization of new variables
3  clear
4  u=70 //m/s
5  a=20 //degrees
```

```
 6  b =15  //m
 7  c =25  //m
 8  r =1.2  //kg/m^3
 9  // calculations
10  AR=b^2/(0.5*b*c)
11  a=a*%pi/180
12  Cl=(0.963+1.512*AR)*sin(a)
13  W=Cl*0.5*r*u^2*(b*c/2)
14  D=W*tan(a)
15  // results
16  printf('Airplane weight is %.1f N',W)
17  printf('\n Drag is %.1f N',D)
```

Chapter 10

Elements of Inviscid Compressible flow

Scilab code Exa 10.1 Chapter10 Example1

```
1  clc
2  //initialization of new variables
3  clear
4  T=300  //k
5  gama=1.4
6  R=286.6
7  //calculations
8  a=sqrt(gama*R*T)
9  //results
10 printf('The speed of sound in air is %.2f m/s',a)
```

Scilab code Exa 10.2 Chapter10 Example2

```
1  clc
2  //initialization of new variables
3  clear
```

```
4  T0 =850  //k
5  T=270  //k
6  gama =1.4
7  //calculations
8  M=sqrt(2/(gama-1)*(T0/T-1))
9  //results
10 printf('M = %.2f',M)
```

Scilab code Exa 10.3 Chapter10 Example3

```
1  clc
2  //initialization of new variables
3  clear
4  M=1
5  T0 =300  //k
6  P0 =4  //atm
7  gama =1.4
8  //calculations
9  Tr=1+(gama-1)*M^2/2
10 Pr=Tr^(gama/(gama-1))
11 P=P0/Pr
12 T=T0/Tr
13 //results
14 printf('At the section:')
15 printf('\n Pressure is %.2f atm',P)
16 printf('\n Temperature is %.2f K',T)
```

Scilab code Exa 10.5 Chapter10 Example5

```
1  clc
2  //initialization of new variables
3  clear
4  P0 =4  //atm
```

```scilab
 5  T0 =300  //K
 6  At =5  // cm ^2
 7  Ae =10  // cm ^2
 8  // calculations
 9  // case (1)
10  P1 =3.8  // atm
11  Pr = P0 / P1
12  M1 =0.26   // from the figure
13  Ar =2.32
14  Aa = Ae / Ar   //A*
15  Art = At / Aa  // At /A*
16  Mt =0.64  // from the figure
17  printf ( 'case (1) ')
18  printf ( '\n Exit Mach = %.2 f ',Mt)
19  // case (2)
20  Aer =2.00  // from figure
21  M2 =0.3  // based on the area ratio
22  Pr =0.939
23  P2 = Pr * P0
24  printf ( '\n case (2) ')
25  printf ( '\n back Pressure is %.2 f atm ',P2)
26  printf ( '\n Exit Mach = %.2 f ',M2)
27  printf ( '\n So when the pressure at the exit is
        lowered a bit , the velocity at the throat becomes
         sonic . ')
28  // case (3)
29  Ar =2.00  // from figure
30  M2 =2.2  // based on area ratio
31  Pr =0.094
32  P2 = Pr * P0
33  printf ( '\n case (3) ')
34  printf ( '\n back pressure is %.2 f atm ',P2)
35  printf ( '\n Exit Mach = %.2 f ',M2)
36  printf ( '\n The pressure ratio has to be very smaller
        to create a supersonic nozzle ')
```

Scilab code Exa 10.6 Chapter10 Example6

```scilab
1  clc
2  //initialization of new variables
3  clear
4  T0=2100  //k
5  P0=3.5  //atm
6  At=4  //cm^2
7  Ar=4.0  // Ae/At
8  Pa=1  //atm
9  gama=1.4
10 R=286.6
11 //calculations
12 Me=2.94
13 Pr=0.030
14 Tr=0.366
15 // from Isentropic table for Area ratio = 4
16 Pe=Pr*P0
17 Te=T0*Tr
18 ue=Me*sqrt(gama*R*Te)
19 re=Pe*10^5/(R*Te)
20 Ae=At*Ar
21 Ae=Ae*10^-4
22 Fx=re*ue^2*Ae+(Pe*10^5-0)*Ae
23 printf('The thrust in space is %.2f N',Fx)
24 // at sea level
25 M1=2.9
26 M2=sqrt((2+(gama-1)*M1^2)/(gama*(2*M1^2-1)+1))
27 P0r=0.358
28 Ar=3.85  //Isentropic table
29 Aer=1.433
30 Me=0.45
31 Per=0.870
32 Tr=0.961
```

```
33  // All the values from isentropic table
34  Pe=P0*P0r*Per
35  Te=T0*Tr
36  ue=Me*sqrt(gama*R*Te)
37  re=Pe*10^5/(R*Te)
38  Fx=re*ue^2*Ae+(Pe*10^5-Pa*10^5)*Ae
39  printf('\n The thrust at sea level is %.2f N',Fx)
```

Chapter 11

Fluid Machinary

Scilab code Exa 11.1 Chapter11 Example1

```scilab
1 clc
2 // initialization of new variables
3 clear
4 r=0.3 //m
5 w=3000 //RPM
6 Cz=61 //m/s
7 th=45 // degrees
8 // calculations
9 U=%pi*2*r*w/60
10 beta1=atan(U/Cz)
11 beta1=beta1*180/%pi
12 beta2=th
13 DCth=U-Cz
14 // results
15 printf('Beta_1 = %d degrees',beta1)
```

Scilab code Exa 11.2 Chapter11 Example2

```scilab
1  clc
2  // initialization of new variables
3  clear
4  Cz =120  //m/s
5  R_av =0.5  //m
6  T01 =300  //k
7  w =4000  //RPM
8  alpha1 =22  // degrees
9  beta2 =27  // degrees
10 eta =0.98
11 Cp =0.24  //  kcal/kg C
12 gama =1.4
13 // calculations
14 Cp=Cp*4200  //1 kcal= 4200 J
15 alpha1 = alpha1 *%pi /180
16 beta2 = beta2 *%pi /180
17 U=2*%pi* R_av *w /60
18 DCth=U-Cz*( tan ( alpha1 )+ tan ( beta2 ))
19 Pr =(1+ eta *U* DCth /( Cp * T01 ))^( gama /( gama -1))
20 // results
21 printf ('The  pressure  rise  ( compression  ratio )  is  %.2
       f ',Pr )
```

Scilab code Exa 11.3 Chapter11 Example3

```scilab
1  clc
2  // initialization  of  new  variables
3  clear
4  beta_d =15  // degrees   flow  turn  angle
5  r2 =0.5  //m   tip  radius
6  r1 =0.2  //m    hub  radius
7  w =5500  //RPM    rotaion  speed
8  Cz =120  //m/s   Axial  velocity
9  T =350  //k    Temperature
10 eta =0.98   // Efficiency
```

```
11  // air properties
12  gama=1.4
13  R=286.6
14  cp=0.24
15  //calculatons
16  cp=cp*4200
17  T01=T
18  Uhub=2*%pi*r1*w/60
19  Utip=2*%pi*r2*w/60
20  w1=sqrt(Utip^2+Cz^2)
21  a1=sqrt(gama*R*T)
22  M1=w1/a1
23  //Hub
24  beta1=atan(Uhub/Cz)
25  beta2=beta1*180/%pi-beta_d
26  beta2=beta2*%pi/180
27  Cp=1-cos(beta1)^2/cos(beta2)^2
28  DCth=Uhub-Cz*tan(beta2)
29  Pr=(1+eta*Uhub*DCth/(cp*T01))^(gama/(gama-1))
30  printf('Hub:')
31  printf('\n The pressure rise coefficient is %.2f',Cp
       )
32  printf('\n Compression ratio = %.3f',Pr)
33  //tip
34  beta1=atan(Utip/Cz)
35  beta2=beta1*180/%pi-beta_d
36  beta2=beta2*%pi/180
37  Cp=1-cos(beta1)^2/cos(beta2)^2
38  DCth=Utip-Cz*tan(beta2)
39  Pr=(1+eta*Utip*DCth/(cp*T01))^(gama/(gama-1))
40  printf('\n tip:')
41  printf('\n The pressure rise coefficient is %.2f',Cp
       )
42  printf('\n Compression ratio = %.3f',Pr)
```

57

Scilab code Exa 11.4 Chapter11 Example4

```scilab
1  clc
2  //initialization of new variables
3  clear
4  r=0.5 //m    average radius
5  Cz=140 //m/s   Axial velocity
6  w=4000 //RPM   turn rate
7  T01=300 //K    Stagnation temperature ahead of rotor
8  alpha1=20 //degrees  Incoming velocity angle
9  Cp=0.45     //Pressure rise coefficient
10 eta=0.98  //efficiency
11 cp=0.24 //specific heat
12 gama=1.4
13 //calculations
14 temp=alpha1 //just to store it
15 cp=cp*4200
16 U=r*w*2*%pi/60
17 alpha1=alpha1*%pi/180
18 beta1=atan(U/Cz-tan(alpha1))
19 beta2=acos(sqrt(cos(beta1)^2/(1-Cp)))
20 DCth=U-Cz*(tan(alpha1)+tan(beta2))
21 Pr=(1+eta*U*DCth/(cp*T01))^(gama/(gama-1))
22 printf('part (1)')
23 printf('\n stagnation pressure rise (ratio)is %.2f',
      Pr)
24 // part (2)
25 Cz=100 //m/s
26 alpha1=atan(U/Cz-tan(beta1))
27 Dalpha=alpha1*180/%pi-temp
28 printf('\n Stator ahead of this stage must be
      rotated by %.1f degrees',Dalpha)
29 DCth=U-Cz*(tan(alpha1)+tan(beta2))
30 Pr=(1+eta*U*DCth/(cp*T01))^(gama/(gama-1))
31 printf('\n part (2)')
32 printf('\n stagnation pressure rise (ratio)is %.2f',
      Pr)
```

Scilab code Exa 11.5 Chapter11 Example5

```scilab
1  clc
2  //initialization of new variables
3  clear
4  R=0.5
5  U=290  //m/s
6  c1=150  //m/s
7  alpha1=37  //degrees
8  beta2=alpha1
9  cp=0.24
10 eta=0.85
11 gama=1.4
12 T01=280  //k
13 //calculations
14 cp=cp*4200
15 alpha1=alpha1*%pi/180
16 Cth1=c1*sin(alpha1)
17 DCth=U-2*c1*sin(alpha1)
18 beta1=atan((U-Cth1)/c1*cos(alpha1))
19 Cp=1-cos(beta1)^2/cos(beta2)^2
20 Pr=(1+eta*U*DCth/(cp*T01))^(gama/(gama-1))
21 //results
22 printf('The compression ratio is %.2f',Pr)
```

Scilab code Exa 11.6 Chapter11 Example6

```scilab
1  clc
2  //initialization of new variables
3  clear
4  r1=0.1  //m
5  r2=0.4  //m
```

```
 6  bet =15  // degrees
 7  eta =0.9
 8  cp =0.24
 9  w =5000  //RPM
10  Cth1 =0
11  gama =1.4
12  T01 =300  //K
13  // calculations
14  bet = bet *% pi /180
15  U2 = r2 * w *2*% pi /60
16  U1 = r1 * w *2*% pi /60
17  wr2 = U2 /2
18  cp = cp *4200
19  Cth2 = wr2 * tan ( bet ) + U2
20  Tr =( U2 * Cth2 - U1 * Cth1 ) /( cp * T01 )
21  Pr =(1+ eta * Tr ) ^( gama /( gama -1) )
22  // results
23  printf ( 'The  pressure  rise  is  %.2 f ' , Pr )
```

Scilab code Exa 11.7 Chapter11 Example7

```
 1  clc
 2  // initialization  of  new  variables
 3  clear
 4  w =1000  //RPM
 5  r1 =0.05  //m
 6  r2 =0.10  //m
 7  bet =0  // degrees
 8  eta =0.9
 9  r =1000  // kg/mˆ3
10  // calculations
11  bet = bet *% pi /180
12  U2 = r2 * w *2*% pi /60
13  Cth2 = U2
14  dp = r * eta * U2 * Cth2
```

```
15  U1=r1*w*2*%pi/60
16  beta1=50  //degrees
17  beta1=90-beta1
18  beta1=beta1*%pi/180
19  c1=U1*tan(beta1)
20  m=r*c1*%pi*r1^2
21  P=m*U2*Cth2
22  //results
23  printf('Pressure rise is %.1f N/m^2',dp)
24  printf('\n mass flow rate is %.2f kg/s',m)
25  printf('\n Power = %.2f W',P)
26
27  //wrong answer for pressure rise part in text
```

Scilab code Exa 11.8 Chapter11 Example8

```
1   clc
2   //initialization of new variables
3   clear
4   S=3  //cm^2
5   m=15  //kg/s
6   alpha2=68.5  //degrees
7   r=0.3  //m
8   w=1000  //RPM
9   ma=100  //kg
10  rho=1000  //kg/m^3
11  g=9.8  //m/s^2
12  //calculations
13  S=S*10^-4
14  alpha2=alpha2*%pi/180
15  U=r*w*2*%pi/60
16  c2=m/(rho*S)
17  cz=c2*cos(alpha2)
18  beta2=atan((c2*sin(alpha2)-U)/cz)
19  P=m*U*2*cz*tan(beta2)
```

```
20  v=P/(ma*g)
21  //results
22  printf('beta_2 = %.1f degrees',beta2*180/%pi)
23  printf('\n v = %.2f m/s',v)
```

Scilab code Exa 11.9 Chapter11 Example9

```
 1  clc
 2  //initialization of new variables
 3  clear
 4  r=0.3 //m
 5  w=7000 //RPM
 6  T01=1200 //K
 7  rho2=0.5 //kg/m^3
 8  R=0.5
 9  beta2=30 //degrees
10  eta=0.9
11  gama=1.4
12  cp=0.24
13  //calculations
14  cp=cp*4200
15  U=r*w*2*%pi/60
16  beta2=beta2*%pi/180
17  // to solve for c2 and w2
18  //Ax=b
19  A=[-sin(%pi/2-beta2) -sin(beta2)
20      cos(%pi/2-beta2) -cos(beta2)]
21  b=[-U;0]
22  x=inv(A)*b
23  w2=x(2)
24  c2=x(1)
25  wt=U*(U-2*w2*sin(beta2))
26  Tr=wt/(cp*T01)
27  Pr=(1-Tr/eta)^(gama/(gama-1))
28  //results
```

```
29  printf('The power of the turbine (per unit mass) is
       %.2f m^2/s^2',wt)
30  printf('\n The pressure ratio is %.3f',Pr)
31  printf('\n Because R = %.2f, half of pressure drop
       takes place in turbine',R)
```

Scilab code Exa 11.10 Chapter11 Example10

```
1  clc
2  //initialization of new variables
3  clear
4  r2=0.1 //m
5  m=1 //kg/s
6  T01=1200 //K
7  alpha2=65 //degrees
8  c2=330 //m/s
9  rho2=0.5 //kg/m^3
10 eta=0.9
11 gama=1.4
12 cp=0.24
13 //calculations
14 alpha2=alpha2*%pi/180
15 cp=cp*4200
16 Cthd=c2*sin(alpha2)
17 U=Cthd/2
18 P=m*U*Cthd
19 Tr=U*Cthd/(cp*T01)
20 Pr=(1-Tr/eta)^(gama/(gama-1))
21 RPM=U/(2*%pi*r2)
22 //results
23 printf('part (a)')
24 printf('\n Power generated is %.1f W',P)
25 printf('part (b)')
26 printf('\n Stagnation pressure drop is %.3f ',Pr)
27 printf('\n In rotor, zero static pressure drop takes
```

```
        place')
28  printf('\n part (c)')
29  printf('\n RPM = %d RPM',RPM*60)
```

Scilab code Exa 11.11 Chapter11 Example11

```
1  clc
2  //initialization of new variables
3  clear
4  r=0.1  //m
5  RPM=1000  //RPM
6  c2=30  //m/s
7  S=2  //cm^2
8  beta3=60  //degrees
9  alpha2=90  //degrees
10 rho=1000  //kg/m^3
11 //calculations
12 beta3=beta3*%pi/180
13 alpha2=alpha2*%pi/180
14 S=S*10^-4
15 U=RPM*r*2*%pi/60
16 w2=c2-U
17 w3=w2
18 CthD=w2*sin(alpha2)+w2*sin(beta3)
19 m=rho*c2*S
20 T=m*r*CthD
21 P=m*U*CthD
22 //results
23 printf('mass flow rate is %.2f kg/s',m)
24 printf('\n Torque T = %.2f N m',T)
25 printf('\n Power P = %.2f W',P)
```

Scilab code Exa 11.12 Chapter11 Example12

```
 1  clc
 2  //initialization of new variables
 3  clear
 4  P=5  //kW
 5  U=30  //km/h
 6  eta=70  //percent
 7  rho=1.22  //kg/m^3
 8  //calculations
 9  eta=eta/100
10  P=P*1000
11  R=sqrt(P*27/(8*eta*rho*(U/3.6)^3*%pi))
12  //results
13  printf('R = %.2f m',R)
```