Scilab Textbook Companion for Introduction To Flight by J. D. Anderson Jr.[1]

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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

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Chapter 2

Fundamental Thoughts

check Appendix AP 101 for dependency:

2_1data.sci

Scilab code Exa 2.1 Example 1

```
pathname=get_absolute_file_path('2_1.sce')
filename=pathname+filesep()+'2_1data.sci'
exec(filename)
T=p/((density)*(R))
printf("\Answer:\n")
printf("\n\Temperature at that point %f K\n\n",T)
```

check Appendix AP 100 for dependency:

2_2data.sci

Scilab code Exa 2.2 Example 2

```
pathname=get_absolute_file_path('2_2.sce')
filename=pathname+filesep()+'2_2data.sci'
```

```
exec(filename)

disp(M,"Mass in Kg",M1,"Mass in pound");
```

check Appendix AP 99 for dependency:

2_3data.sci

Scilab code Exa 2.3 Example 3

```
pathname=get_absolute_file_path('2_3.sce')
filename=pathname+filesep()+'2_3data.sci'
exec(filename)
density=P/(R*T);
v=1/density;//specific volume
printf("\Answer:\n")
printf("\n\Density of air: %f Kg/m^3\n\n",density)
printf("\n\Specific volume of air: %f m^3/Kg\n\n",v)
```

check Appendix AP 98 for dependency:

2_4data.sci

Scilab code Exa 2.4 Example 4

```
pathname=get_absolute_file_path('2_4.sce')
filename=pathname+filesep()+'2_4data.sci'
exec(filename)
printf("\Answer:\n")
printf("\n\Density of air at the given point: %f Kg/
   m^3\n\n",density)
```

check Appendix AP 97 for dependency:

2_5data.sci

Scilab code Exa 2.5 Example 5

```
pathname=get_absolute_file_path('2_5.sce')
filename=pathname+filesep()+'2_5data.sci'
exec(filename)
function[unit]=Conversion(SI)
     unit=(9.8*(0.3048)^2)*(SI)/4.448;
 endfunction
 disp("1lb/ft^2=(9.8*(0.3048)^2)*/4.448)kgf/m^2")
 disp(Conversion(280.8),"wing loading in lb/ft^2 for
    F-117A stealth fighter");
```

check Appendix AP 96 for dependency:

2_6data.sci

Scilab code Exa 2.6 example 6

```
pathname=get_absolute_file_path('2_6.sce')
filename=pathname+filesep()+'2_6data.sci'
exec(filename)
function[ftPerSecond]=conversion(MilePerHour)
    ftPerSecond=(5280*MilePerHour)/3600;
endfunction
function[meterPerSecond]=conversion1(MilePerHour)
    meterPerSecond=(1609.344*MilePerHour)/3600;
endfunction
disp("1 ftPerSecond=(5280*MilePerHour)/3600")

disp(conversion(60),"velocity in terms of ft/s");

disp("1 meterPerSecond=(1609.344*MilePerHour)/3600")
disp(conversion1(60),"velocity in terms of m/s");
```

Chapter 3

The Standard Atmosphere

check Appendix AP 95 for dependency:

`3_01data.sci`

Scilab code Exa 3.01 Example 1

```
pathname=get_absolute_file_path('3_01.sce')
filename=pathname+filesep()+'3_01data.sci'
exec(filename)
printf("\Answer:\n")
printf("\pressure at an altitude of 14 Km: %f N/m^2\n",P2)
printf("\n\density at an altitude of 14 Km: %f Kg/m^3\n\n",D2)
```

---

check Appendix AP 94 for dependency:

`3_02data.sci`

Scilab code Exa 3.02 Example 2

```
pathname=get_absolute_file_path('3_02.sce')
filename=pathname+filesep()+'3_02data.sci'
exec(filename)
printf("\Answer:\n")
printf("\n\pressure altitude: %f Km\n\n",P1)
printf("\n\ temperature altitude: %f Km\n\n",T1)
printf("\n\density altitude: %f Km\n\n",D1)
```

check Appendix AP 93 for dependency:

`3_03data.sci`

Scilab code Exa 3.03 `Example 3`

```
pathname=get_absolute_file_path('3_03.sce')
filename=pathname+filesep()+'3_03data.sci'
exec(filename)
printf("\Answer:\n")
printf("\n\Temperature of air at flying altitude of
    airplane: %f K\n\n",T)
```

check Appendix AP 92 for dependency:

`3_04data.sci`

Scilab code Exa 3.04 `Example 4`

```
pathname=get_absolute_file_path('3_04.sce')
filename=pathname+filesep()+'3_04data.sci'
exec(filename)
printf("\Answer:\n")
printf("\pressur altitude: %f Km\n",Hp)
printf("\n\density altitude : %f Km\n\n",Hd)
```

Chapter 4

Basic Aerodynamics

check Appendix AP 91 for dependency:

4_01data.sci

Scilab code Exa 4.01 Example 1

```
pathname=get_absolute_file_path('4_01.sce')
filename=pathname+filesep()+'4_01data.sci'
exec(filename)
printf("\Answer:\n")
printf("\n\area of the duct exit: %f m^2\n\n",A2)
```

---

check Appendix AP 90 for dependency:

4_02data.sci

Scilab code Exa 4.02 Example 1

```
pathname=get_absolute_file_path('4_02.sce')
filename=pathname+filesep()+'4_02data.sci'
exec(filename)
```

```
printf("\Answer:\n")
printf("\n\density of air at the duct exit: %f Kg/m
    ^3\n\n",D2)
```

check Appendix AP 89 for dependency:

4_03data.sci

Scilab code Exa 4.03 Example 3

```
pathname=get_absolute_file_path('4_03.sce')
filename=pathname+filesep()+'4_03data.sci'
exec(filename)
disp("P1+(D*V1^2/2)=Pa+(D*Va^2/2)","Bernoulli
    equation");
Va=[(2*(P1-Pa)/D)+(V1)^2]^0.5;disp(Va,"Va=")
printf("\Answer:\n")
printf("\n\velocity at a point A on airfoil: %f m/s\
    n\n",Va)
```

check Appendix AP 88 for dependency:

4_04data.sci

Scilab code Exa 4.04 Example 4

```
pathname=get_absolute_file_path('4_04.sce')
filename=pathname+filesep()+'4_04data.sci'
exec(filename)
printf("\Answer:\n")
printf("\n\pressure at the duct exit: %f N/m^2\n\n",
    P2)
```

check Appendix AP 87 for dependency:

4_05data.sci

Scilab code Exa 4.05 Example 5

```
pathname=get_absolute_file_path('4_05.sce')
filename=pathname+filesep()+'4_05data.sci'
exec(filename)
D=1.067*D*V^2*R;
printf("\Answer:\n")
printf("\n\Aerodynamic force exerted by surface
    pressure distribution: %f N\n\n",D)
```

check Appendix AP 86 for dependency:

4_06data.sci

Scilab code Exa 4.06 Example 6

```
pathname=get_absolute_file_path('4_06.sce')
filename=pathname+filesep()+'4_06data.sci'
exec(filename)
printf("\Answer:\n")
printf("\n\internal energy per unit mass in SI unit:
     %f J/Kg.K\n\n",e)
printf("\n\internal energy per unit mass in English
    enginering unit: %f Ft.Lb/slug\n\n",e1)
printf("\n\enthalpy per unit mass in SI unit: %f J/
    Kg.K\n\n",h)
printf("\n\enthalpy per unit mass in English
    enginering unit: %f Ft.Lb/slug\n\n",h1)
```

check Appendix AP 85 for dependency:

4_07data.sci

Scilab code Exa 4.07 Example 7

```
pathname=get_absolute_file_path('4_07.sce')
filename=pathname+filesep()+'4_07data.sci'
exec(filename)
disp("P2/P1=(T2/T1)^y/y-1","For isentropic flow","
   let P2 be the pressure at that point of wing");
P2=P1*(T/T1)^(y/(y-1));disp(P2,"P2=")
printf("\Answer:\n")
printf("\n\Pressure at this point: %f N/m^2\n\n",P2)
```

check Appendix AP 84 for dependency:

`4_08data.sci`

Scilab code Exa 4.08 Example 8

```
pathname=get_absolute_file_path('4_08.sce')
filename=pathname+filesep()+'4_08data.sci'
exec(filename)
disp("T2=T1*(P2/P1)^((y-1)/y)","from isentropic
   condition:")
T2=T1*(P2/P1)^((y-1)/y)//temperature at exit
printf("\Answer:\n")
printf("\n\Gas temperature at the exit: %f K\n\n",T2
   )
```

check Appendix AP 83 for dependency:

`4_09data.sci`

Scilab code Exa 4.09 Example 9

```
pathname=get_absolute_file_path('4_09.sce')
filename=pathname+filesep()+'4_09data.sci'
exec(filename)
disp("So V1^2=2Cp*(To-T1)","CpTo=CpT1+(V1^2)/2","From energy equation:","let V1 be the velocity of throat")
V1=(2*Cp*(To-T1))^0.5;
printf("\n\Velocity at throat: %f m/s\n\n",V1)
disp("So Ve^2=2Cp*(To-Te)","CpTo=CpTe+(Ve^2)/2","From energy equation:","let Ve be the velocity of exit")
Ve=(2*Cp*(To-Te))^0.5;
printf("\n\Velocity at the exit: %f m/s\n\n",Ve)
disp("A1=Mt/(D1*V1)","Area of throat")
A1=Mt/(D1*V1);
printf("\n\Area of throat: %f m^2\n\n",A1)
disp("Ae=Mt/(De*Ve)","Area of the exit")
Ae=Mt/(De*Ve);
printf("\n\Area of the exit: %f m^2\n\n",Ae)
```

check Appendix AP 82 for dependency:

`4_10data.sci`

Scilab code Exa 4.10 Example 10

```
pathname=get_absolute_file_path('4_10.sce')
filename=pathname+filesep()+'4_10data.sci'
exec(filename)
disp("So Va^2=2Cp*(T-Ta)+V^2","CpT+(V^2)/2=CpTa+(Va^2)/2","From energy equation:","let Va be the velocity of the point A")
Va=(2*Cp*(T-Ta)+V^2)^0.5;disp(Va,"Va=")
printf("\Answer:\n")
```

```
printf("\n\Velocity at point A: %f m/s\n\n",Va)
```

check Appendix AP 81 for dependency:

4_11data.sci

Scilab code Exa 4.11 Example 11

```
pathname=get_absolute_file_path('4_11.sce')
filename=pathname+filesep()+'4_11data.sci'
exec(filename)
disp("Mach No M=V/a");
M=V/a;disp(M,"M=")
printf("\Answer:\n")
printf("\n\Mach No of the jet transport: %f\n\n",M)
```

check Appendix AP 80 for dependency:

4_12data.sci

Scilab code Exa 4.12 Example 12

```
pathname=get_absolute_file_path('4_12.sce')
filename=pathname+filesep()+'4_12data.sci'
exec(filename)
disp("Mach No at Throat Mt=V1/a");
Mt=V1/a;disp(Mt,"Mt=")
disp("Mach No at Throat Me=Ve/Ae");
Me=Ve/Ae;disp(Me,"Me=")
printf("\Answer:\n")
printf("\n\Mach No at throat: %f\n\n",Mt)
printf("\n\Mach No at exit: %f\n\n",Me)
```

check Appendix AP 79 for dependency:

4_13data.sci

Scilab code Exa 4.13 Example 13

```
pathname=get_absolute_file_path('4_13.sce')
filename=pathname+filesep()+'4_13data.sci'
exec(filename)
disp("(2(P1-P2)/(D1(1-(A2/A1)^2)))^0.5=(2*(Dp)/(D1
   *(1-r^2)))^0.5","Airflow velocity at test section
    V=");
V=(2*(Dp)/(D1*(1-r^2)))^0.5;disp(V,"V=");
printf("\Answer:\n")
printf("\n\Airflow velocity in the test section: %f
   m/s\n\n",V)
```

check Appendix AP 78 for dependency:

4_14data.sci

Scilab code Exa 4.14 Example 14

```
pathname=get_absolute_file_path('4_14.sce')
filename=pathname+filesep()+'4_14data.sci'
exec(filename)
disp("P2+D(V2^2-V1^2)/2","pressure at reservoir P1="
   )
P1=P2+D*(V2^2-V1^2)/2;disp(P1,"P1=")
disp("Mt=D*A1*V1","mass flow rate :")
Mt=D*A1*V1;disp(Mt,"Mt=")
printf("\Answer:\n")
printf("\n\pressure required to have a velocity of
   40 m/s at test section: %f N/m^2\n\n",P1)
printf("\n\mass flow through the wind tunnel: %f Kg/
   s\n\n",Mt)
```

check Appendix AP 77 for dependency:

```
4_15data.sci
```

Scilab code Exa 4.15 Example 15

```
pathname=get_absolute_file_path('4_15.sce')
filename=pathname+filesep()+'4_15data.sci'
exec(filename)
disp("V2 propertional to (P2-P1)^0.5","velocity in
    test section is propertional to square root of
    pressure difference")
V2=(40)*2^(0.5);disp(V2,"velocity after pressure
    difference is doubled is squareroot 2 times 40")
disp("(2(P1-P2)/(D(1-(A2/A1)^2)))^0.5=(2*(Dp)/(D
    *(1-(1/R)^2)))^0.5","Airflow velocity at test
    section V3=");
V3=(2*(Dp)/(D*(1-(1/R)^2)))^0.5;disp(V3,"V3=");
printf("\Answer:\n")
printf("\n\Airflow velocity in the test section
    after doubling pressure difference: %f m/s\n\n",
    V2)
printf("\n\Airflow velocity in the test section
    after doubling contraction ratio: %f m/s\n\n",V3)
```

check Appendix AP 76 for dependency:

```
4_16data.sci
```

Scilab code Exa 4.16 Example 16

```
pathname=get_absolute_file_path('4_16.sce')
filename=pathname+filesep()+'4_16data.sci'
```

```
exec(filename)
disp("Vt=(2(Po-P)/D)^0.5","True velocity of airplane")
Vt=sqrt(2*(Po-P)/D);disp(Vt,"Vt=");
disp("Ve=(2(Po-P)/Ds)^0.5","Eqivalent airspeed of airplane")
Ve=sqrt(2*(Po-P)/Ds);disp(Ve,"Ve=");
printf("\Answer:\n")
printf("\n\True velocity of the airplane: %f m/s\n\n",Vt)
printf("\n\Equivalent airspeed of the airplane: %f m/s\n\n",Ve)
```

check Appendix AP 75 for dependency:

`4_17data.sci`

Scilab code Exa 4.17 Example 17

```
pathname=get_absolute_file_path('4_17.sce')
filename=pathname+filesep()+'4_17data.sci'
exec(filename)
disp("M1^2=2*[(Po/P1)^((y-1)/y)-1]/(y-1))","let Mach no at which the airplane flying is M1 then")
M1=sqrt(2*[(Po/P1)^((y-1)/y)-1]/(y-1));disp(M1,"M1=");
a1=sqrt(y*R*T);disp(a1,"a1=(y*R*T)^0.5","speed of sound at that point");
V1=sqrt(2*a1^2*[(Po/P1)^((y-1)/y)-1]/(y-1));
disp(V1,"V1=","V1^2=2*a1^2*[(Po/P1)^((y-1)/y)-1]/(y-1)","equvalent air speed V1")
R=((y-1)/y);
Vc=sqrt([2*a^2*[(((Po-P1)/P)+1)^((y-1)/y)-1]/(y-1)]);
disp(Vc,"Vc=","Vc^2=2*a^2*[(((Po-P1)/P)+1)^((y-1)/y)-1]/(y-1)","caliberated air speed Vc")
```

```
printf("\Answer:\n")
printf("\n\mach no at which airplane is flying: %f \
   n\n",M1)
printf("\n\True airspeed of the airplane: %f m/s\n\n
   ",V1)
printf("\n\caliberated airspeed of the airplane: %f
   m/s\n\n",Vc)
```

check Appendix AP 74 for dependency:

`4_18data.sci`

Scilab code Exa 4.18 Example 18

```
pathname=get_absolute_file_path('4_18.sce')
filename=pathname+filesep()+'4_18data.sci'
exec(filename)
Po=P*[(y+1)^2*M^2/((4*y*M^2)-2*(y-1))]^3.5*(1-y+2*y*
   M^2)/(y+1)
disp("Po=P1*[(y+1)^2*M^2/((4*y*M^2)-2*(y-1))
   ]^3.5*(1-y+2*y*M^2)/(y+1)","pressure measured by
   pitot tube Po")
printf("\Answer:\n")
printf("\n\pressure measured by pitot tube: %f N/m
   ^2\n\n",Po)
```

check Appendix AP 73 for dependency:

`4_19data.sci`

Scilab code Exa 4.19 Example 19

```
pathname=get_absolute_file_path('4_19.sce')
filename=pathname+filesep()+'4_19data.sci'
```

```
exec(filename)
Ma=[[(Po/Pa)^((y-1)/y)-1]*2/(y-1)]^0.5;disp(Ma,"Ma="
    ,"Ma=[(Po/Pa)^((y-1)/y)-1]*2/(y-1)","Mach no at
    point A")
Ta=Toa/[1+(y-1)*Ma^2/2];
disp(Ta,"Ta=","Ta=Toa/[1+(y-1)*Ma^2/2]","static
    temperature at A")
Va=sqrt(y*R*Ta)*Ma;
disp(Va,"Va=","velocity at A =a*Ma,where a(sqrt(y*R*
    Ta)) is apeed of sound at A")
printf("\Answer:\n")
printf("\n\Mach No at A: %f \n\n",Ma)
printf("\n\velocity at A: %f m/s\n\n",Va)
```

check Appendix AP 72 for dependency:

4_20data.sci

Scilab code Exa 4.20 Example 20

```
pathname=get_absolute_file_path('4_20.sce')
filename=pathname+filesep()+'4_20data.sci'
exec(filename)
To=Te*A
disp(To,"To=","To=Te*(1+(y-1)*Me^2/2)","let
    reservoir temperature required is To ")
Po=Pe*A^(y/(y-1));
disp(Po,"Po=","Po=Pe*((1+(y-1)*Me^2/2))^y/y-1","let
    reservoir pressure required is Po ")
r=sqrt((2*A/(y+1))^((y+1)/(y-1))/Me^2)
disp(r,"Ae/At=","Ae/At=sqrt((2*(1+(y-1)*Me^2/2)/(y
    +1))^((y+1)/(y-1))/Me^2","Area ratio required is
    equal to")
printf("\Answer:\n")
printf("\n\ required reservoir temperature: %f K\n\n
    ",To)
```

```
printf("\n\ required reservoir pressure: %f N/m^2\n\n",Po)
printf("\n\ required Area Ratio: %f \n\n",r)
```

check Appendix AP 71 for dependency:

`4_21data.sci`

Scilab code Exa 4.21 Example 21

```
pathname=get_absolute_file_path('4_21.sce')
filename=pathname+filesep()+'4_21data.sci'
exec(filename)
Pstag=Pe*[(y+1)^2*Me^2/((4*y*Me^2)-2*(y-1))]^(y/(y-1))*(1-y+2*y*Me^2)/(y+1)
disp(Pstag,"Pstag=","Pstag=Pe*[(y+1)*Me^2/((4*y*Me^2)-2*(y-1))]^(y/(y-1))*(1-y+2*y*Me^2)/(y+1)","the stagnation presure is given by Pstag")
Dstag=Pstag/(R*Tstag);
disp(Dstag,"Dstag=","Dstag=Pstag/(R*Tstag)","the stagnation density is given by Dstag")
printf("\Answer:\n")
printf("\n\ Stagnation temperature: %f K\n\n",Tstag)
printf("\n\ Stagnation pressure: %f N/m^2\n\n",Pstag)
printf("\n\ Stagnation density: %f Kg/m^3\n\n",Dstag)
```

check Appendix AP 70 for dependency:

`4_22data.sci`

Scilab code Exa 4.22 Example 22

```
pathname=get_absolute_file_path('4_22.sce')
filename=pathname+filesep()+'4_22data.sci'
exec(filename)
Ve=Ae*Me;disp(Ve,"Ve=","velocity at exit Ve=Ae*Me")
Mt=Dt*At*Vt;disp(Mt,"Mt=Dt*At*Vt","mass flow through
    nozzle Mt")
printf("\Answer:\n")
printf("\n\Velocity at exit: %f m/s\n\n",Ve)
printf("\n\mass flow through nozzle: %f Kg/m^3\n\n",
   Mt)
```

check Appendix AP 69 for dependency:

`4_23data.sci`

Scilab code Exa 4.23 Example 23

```
pathname=get_absolute_file_path('4_23.sce')
filename=pathname+filesep()+'4_23data.sci'
exec(filename)
t=5.2*x/Re^0.5;disp(t,"t=","boundary layer thickness
    t=5.2*x/Re^0.5")
D=q*S*Cf;disp(D,"D=","drag on one surface of the
   plate given by D=q*s*Cf")
disp(2*D,"Dn=","Net drag Dn is two times both
   surface i.e 2D")
printf("\Answer:\n")
printf("\n\Boundary layer thickness at downstream
   edge: %f m\n\n",t)
printf("\n\The drag force on plate: %f N\n\n",2*D)
```

check Appendix AP 68 for dependency:

`4_24data.sci`

Scilab code Exa 4.24 Example 24

```
pathname=get_absolute_file_path('4_24.sce')
filename=pathname+filesep()+'4_24data.sci'
exec(filename)
Tw1=q*Cf1;disp(Tw1,"Tw1=","Tw1=q*Cf1","shear stress at 1 cm Tw1:");
Tw2=q*Cf2;disp(Tw2,"Tw2=","Tw2=q*Cf2","shear stress at 1 cm Tw2:");
printf("\Answer:\n")
printf("\n\Local shear stress at 1 cm: %f N/m^2\n\n",Tw1)
printf("\n\Local shear stress at 5 cm: %f N/m^2",Tw2)
disp("Hence Tw decreases with distance in flow direction");
```

check Appendix AP 67 for dependency:

`4_25data.sci`

Scilab code Exa 4.25 Example 25

```
pathname=get_absolute_file_path('4_25.sce')
filename=pathname+filesep()+'4_25data.sci'
exec(filename)
T=0.37*x/Re^0.2;disp(T,"T=","T=0.37*x/Re^0.2","Thickness at trailing edge T:");
Df=q*S*Cf;disp(Df,"Df=","Df=q*S*Cf","Drag at top surface")
printf("\Answer:\n")
printf("\n\Thickness at trailing edge: %f m\n\n",T)
printf("\n\Total Drag: %f N",2*Df)
```

check Appendix AP 66 for dependency:

`4_26data.sci`

Scilab code Exa 4.26 Example 26

```
pathname=get_absolute_file_path('4_26.sce')
filename=pathname+filesep()+'4_26data.sci'
exec(filename)
Tw1=q*Cf1;disp(Tw1,"Tw1=","Tw1=q*Cf1","shear stress
    at 1 cm Tw1:");
Tw2=q*Cf2;disp(Tw2,"Tw2=","Tw2=q*Cf2","shear stress
    at 1 cm Tw2:");
printf("\Answer:\n")
printf("\n\Local shear stress at 1 cm: %f N/m^2\n\n"
    ,Tw1)
printf("\n\Local shear stress at 5 cm: %f N/m^2",Tw2
    )
```

check Appendix AP 65 for dependency:

`4_27data.sci`

Scilab code Exa 4.27 Example 27

```
pathname=get_absolute_file_path('4_27.sce')
filename=pathname+filesep()+'4_27data.sci'
exec(filename)
Tw=q*Cf;disp(Tw,"Tw=","Tw=q*Cf","shear stress at
    point 0.6096 m Tw:");
printf("\Answer:\n")
printf("\n\shear stress at a point 0.6096m
    downstream of the leading edge: %f m\n\n",Tw)
```

check Appendix AP 64 for dependency:

`4_28data.sci`

Scilab code Exa 4.28 Example 28

```
pathname=get_absolute_file_path('4_28.sce')
filename=pathname+filesep()+'4_28data.sci'
exec(filename)
Ds=q*S*0.074/Re^0.2;disp(Ds,"Ds=","Ds=q*S*0.074/Re
    ^0.2","turbulent drag over complete area(A+B)");
Da=q*A*0.074/Ret^0.2;disp(Da,"Da=","Da=q*A*0.074/Ret
    ^0.2","turbulent drag over area A");
disp(Ds-Da,"Db=","turbulent drag over area B Db:");
    Db=Ds-Da;
Dl=q*A*1.328/Ret^0.5;disp(Dl,"Dl=","Dl=q*A*1.328/Ret
    ^0.5","laminar drag over area A");
Dn=Db+Dl;disp(Dn,"Dn=","Dn=Db+Dl","Net drag Dn")
printf("\Answer:\n")
printf("\n\Skin friction Drag over wings of biplane
    (4 surfaces): %f N\n\n",4*Dn)
```

Chapter 5

Airfoils Wings and Other Aerodynamic Shapes

check Appendix AP 63 for dependency:

5_01data.sci

Scilab code Exa 5.01 Example 1

```
pathname=get_absolute_file_path('5_01.sce')
filename=pathname+filesep()+'5_01data.sci'
exec(filename)
L=q*c*Cl;disp(L,"L=","L=q*c*Cl","Lift per unit span
   L:")
D=q*c*Cd;disp(D,"D=","D=q*c*Cd","Drag per unit span
   D:")
M=q*c*Cm*c;disp(M,"M=","M=q*c*Cm*c","Moment per unit
    span M:")
printf("\Answer:\n")
printf("\n\Lift about the quarter chord,per unit
   span: %f N\n\n",L)
printf("\n\Drag about the quarter chord,per unit
   span: %f N\n\n",D)
printf("\n\moment about the quarter chord,per unit
   span: %f N.m\n\n",M)
```

check Appendix AP 62 for dependency:

5_02data.sci

Scilab code Exa 5.02 Example 2

```
pathname=get_absolute_file_path('5_02.sce')
filename=pathname+filesep()+'5_02data.sci'
exec(filename)
printf("\Answer:\n")
printf("\n\angle of attack for 700 N lift: %f degree
    \n\n",a)
printf("\n\angle of attack for zero lift:: %f degree
    \n\n",a1)
```

check Appendix AP 61 for dependency:

5_03data.sci

Scilab code Exa 5.03 Example 3

```
pathname=get_absolute_file_path('5_03.sce')
filename=pathname+filesep()+'5_03data.sci'
exec(filename)
Cp=(P1-P)/q;disp(Cp,"Cp=","Cp=(P1-P)/q","pressure
    coefficient Cp :")
printf("\Answer:\n")
printf("\n\pressure coefficient at this point of
    wing: %f \n\n",Cp)
```

check Appendix AP 60 for dependency:

5_04data.sci

Scilab code Exa 5.04 Example 4

```
pathname=get_absolute_file_path('5_04.sce')
filename=pathname+filesep()+'5_04data.sci'
exec(filename)
Cp=(P1-P)/q;disp(Cp,"Cp=","Cp=(P1-P)/q","pressure
    coefficient Cp :")
printf("\Answer:\n")
printf("\n\pressure coefficient : %f \n\n",Cp)
```

check Appendix AP 59 for dependency:

`5_05data.sci`

Scilab code Exa 5.05 Example 5

```
pathname=get_absolute_file_path('5_05.sce')
filename=pathname+filesep()+'5_05data.sci'
exec(filename)
Cp=Cpo/(sqrt(1-M^2));disp(Cp,"Cp=","Cp=Cpo/(sqrt(1-M
    ^2))","pressure coefficient Cp :")
printf("\Answer:\n")
printf("\n\pressure coefficient : %f \n\n",Cp)
```

check Appendix AP 58 for dependency:

`5_06data.sci`

Scilab code Exa 5.06 Example 6

```
pathname=get_absolute_file_path('5_06.sce')
filename=pathname+filesep()+'5_06data.sci'
exec(filename)
P1=(q*Cp)+P;disp(P1,"P1=","P1=q*Cp+p","pressure at
   this point P1:")
printf("\Answer:\n")
printf("\n\pressure at this point : %f N/m^2\n\n",P1
   )
```

check Appendix AP 57 for dependency:

`5_07data.sci`

Scilab code Exa 5.07 Example 7

```
pathname=get_absolute_file_path('5_07.sce')
filename=pathname+filesep()+'5_07data.sci'
exec(filename)
V2=V*((Cp1-Cp2)+(V1/V)^2)^0.5;
disp(V2,"V2=","V2=V*((Cp1-Cp2)+(V1/V)^2)^0.5","
   velocity at point 2 V2:")
printf("\Answer:\n")
printf("\n\Velocity at point 2: %f m/s\n\n",V2)
```

check Appendix AP 56 for dependency:

`5_08data.sci`

Scilab code Exa 5.08 Example 8

```
pathname=get_absolute_file_path('5_08.sce')
filename=pathname+filesep()+'5_08data.sci'
exec(filename)
```

```
Cn=integrate('1-0.95*y','y',0,1.0)-integrate('1-300*y^2 ','y',0,0.1)-integrate('-2.2277+2.2277*y','y',0.1,1.0)
printf("\Answer:\n")
printf("\n\Normal force coefficient : %f \n\n",Cn)
```

check Appendix AP 55 for dependency:

`5_09data.sci`

Scilab code Exa 5.09 Example 9

```
pathname=get_absolute_file_path('5_09.sce')
filename=pathname+filesep()+'5_09data.sci'
exec(filename)
Cl=Co/(sqrt(1-M^2));disp(Cl,"Cl=","Cl=Co/(sqrt(1-M^2))","Lift coefficient Cl :")
printf("\Answer:\n")
printf("\n\Lift coefficient at Mach 0.7: %f \n\n",Cl)
```

check Appendix AP 54 for dependency:

`5_10_data.sci`

Scilab code Exa 5.10 Example 10

```
pathname=get_absolute_file_path('5_10.sce')
filename=pathname+filesep()+'5_10_data.sci'
exec(filename)
clf();
i = 1;
```

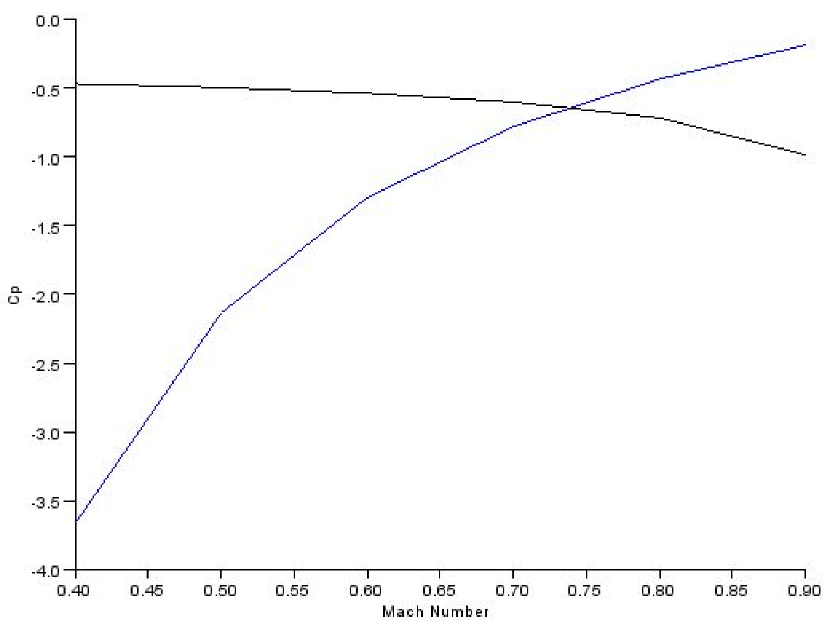

Figure 5.1: Example 10

```
while(i<=length(M))
    Cpcr(i)=(2/(y*M(i)^2))*[[(2+(y-1)*M(i)^2)/(y+1)
       ]^(y/(y-1))-1]
    Cpmin(i)=Cpomin/sqrt(1-M(i)^2);
   i = i+1;
end
xlabel("Mach Number");
ylabel("Cp");
plot2d(M,Cpcr,2);
plot2d(M,Cpmin);
disp("The intersection point of both the graphs i.e
   approx 0.74 is the critical Mach no of the NACA
   -0012 airfoil.")
```

check Appendix AP 53 for dependency:

`5_11_data.sci`

Scilab code Exa 5.11 Example 11

```
pathname=get_absolute_file_path('5_11.sce')
filename=pathname+filesep()+'5_11_data.sci'
exec(filename)
L=q*c*Cl;disp(L,"L=","L=q*c*Cl","lift per unit span
   for mach 3 :")
Dw=q*c*Cd;disp(Dw,"Dw=","Dw=q*c*Cd","Wave drag per
   unit span for mach 3 :")
L1=q1*c*Cl1;disp(L1,"L1=","L1=q1*c*Cl1","lift per
   unit span for mach 2:")
Dw1=q1*c*Cd1;disp(Dw1,"Dw1=","Dw1=q1*c*Cd1","Wave
   drag per unit span for mach 2 :")
```

check Appendix AP 52 for dependency:

`5_12_data.sci`

Scilab code Exa 5.12 example 12

```
pathname=get_absolute_file_path('5_12.sce')
filename=pathname+filesep()+'5_12_data.sci'
exec(filename)
a=L*(M^2-1)^0.5/(4*q*S);
disp(a,"a=","a=L*(M^2-1)^0.5/(4*q*S)","angle of
    attack at sea level:")
a1=L*(M^2-1)^0.5/(4*q1*S);
disp(a1,"a1=","a1=L*(M^2-1)^0.5/(4*q1*S)","angle of
    attack at 10 Km:")
printf("\Answer:\n")
printf("\n\angle of attack at sea level: %f degree\n
    \n",a*180/%pi)
printf("\n\angle of attack at 10 Km: %f degree\n\n",
    a1*180/%pi)
```

check Appendix AP 51 for dependency:

`5_13data.sci`

Scilab code Exa 5.13 Example 13

```
pathname=get_absolute_file_path('5_13.sce')
filename=pathname+filesep()+'5_13data.sci'
exec(filename)
L=q*S*4*a/sqrt(M^2-1);
disp(L,"L=","L=q*S*4*a/sqrt(M^2-1)","Lift exerted on
     airplane L:")
printf("\Answer:\n")
printf("\n\Lift exerted on airplane: %f N\n\n",L)
```

check Appendix AP 50 for dependency:

`5_14data.sci`

Scilab code Exa 5.14 Example 14

```
pathname=get_absolute_file_path('5_14.sce')
filename=pathname+filesep()+'5_14data.sci'
exec(filename)
Cl=L/(q*S);
disp(Cl,"Cl=","Cl=L/(q*S)","Lift coefficient Cl:")
printf("\Answer:\n")
printf("\n\Lift coefficient: %f \n\n",Cl)
```

check Appendix AP 49 for dependency:

`5_15data.sci`

Scilab code Exa 5.15 Example 15

```
pathname=get_absolute_file_path('5_15.sce')
filename=pathname+filesep()+'5_15data.sci'
exec(filename)
Cdi=Cl^2/(%pi*e*AR);disp(Cdi,"Cdi=","Cdi=Cl^2/(%pi*e
    *AR)","induced drag coefficient Cdi:")
Di=q*S*Cdi;disp(Di,"Di=","Di=q*S*Cdi","induced drag
    Di:")
printf("\Answer:\n")
printf("\n\induced drag coefficient: %f \n\n",Cdi)
printf("\n\induced drag: %f N\n\n",Di)
```

check Appendix AP 48 for dependency:

`5_16data.sci`

Scilab code Exa 5.16 Example 16

```
pathname=get_absolute_file_path('5_16.sce')
filename=pathname+filesep()+'5_16data.sci'
exec(filename)
Dt=(Cd+Cdi)*S*(D*V^2/2);disp(Dt,"Dt=","Dt=(Cd+Cdi)*S
    *q","total drag Di:")
printf("\Answer:\n")
printf("\n\Totl drag: %f N\n\n",Dt)
```

check Appendix AP 47 for dependency:

`5_17data.sci`

Scilab code Exa 5.17 `Example 17`

```
pathname=get_absolute_file_path('5_17.sce')
filename=pathname+filesep()+'5_17data.sci'
exec(filename)
Cl=a1*(a-a2);disp(Cl,"Cl=","Cl=a1(a-a2)","lift
    coefficient Cl:")
Cd=cd+Cl^2/(%pi*e*AR);disp(Cd,"Cd=","Cd=cd+Cl^2/(%pi
    *e*AR)","total drag coefficient Cd=:")
printf("\Answer:\n")
printf("\n\Lift coefficient: %f \n\n",Cl)
printf("\n\Totl drag coefficient: %f \n\n",Cd)
```

check Appendix AP 46 for dependency:

`5_18data.sci`

Scilab code Exa 5.18 `Example 18`

```
pathname=get_absolute_file_path('5_18.sce')
filename=pathname+filesep()+'5_18data.sci'
exec(filename)
```

```
Di=q*S*Cdi;disp(Di,"Di=","Di=q*S*Cdi","induced drag on one wing Di:")
printf("\Answer:\n")
printf("\n\Induced drag exerted on both the wings: %f N\n\n",2*Di)
```

check Appendix AP 45 for dependency:

`5_19data.sci`

Scilab code Exa 5.19 Example 19

```
pathname=get_absolute_file_path('5_19.sce')
filename=pathname+filesep()+'5_19data.sci'
exec(filename)
disp("comparing the results of part a and b we can see the high-aspect ratio wing experiences a 26% higher increase in Cl than the low-aspect ratio wing.")
```

check Appendix AP 44 for dependency:

`5_20data.sci`

Scilab code Exa 5.20 Example 20

```
pathname=get_absolute_file_path('5_20.sce')
filename=pathname+filesep()+'5_20data.sci'
exec(filename)
V1=sqrt(2*Wt/(D*S*Clm));disp(V1,"V1=","V1=sqrt(2*Wt/(D*S*Clm))","stalling speed for full fuel tank V1:")
V2=sqrt(2*Wf/(D*S*Clm));disp(V2,"V2=","V2=sqrt(2*Wf/(D*S*Clm))","stalling speed for empty fuel tank V1:")
```

```
printf("\Answer:\n")
printf("\n\stalling speed for full fuel tank : %f m/s\n\n",V1)
printf("\n\stalling speed for empty fuel tank : %f m/s\n\n",V2)
```

check Appendix AP 43 for dependency:

`5_21data.sci`

Scilab code Exa 5.21 Example 21

```
pathname=get_absolute_file_path('5_21.sce')
filename=pathname+filesep()+'5_21data.sci'
exec(filename)
V=sqrt(2*Wt/(D*S*Clm));disp(V,"V=","V=sqrt(2*Wt/(D*S*Clm))","stalling speed for Boeing 727 V:")
printf("\Answer:\n")
printf("\n\stalling speed for full fuel tank : %f m/s\n\n",V)
disp("stalling speed for lockhead F-104 is a much higher value than the Boeing 727.","comparison with stalling speed for full fuel tank of example 5.20:")
```

Chapter 6

Elements Of Airplane Performance

Scilab code Exa 6.1.a Example 1 a

```
pathname=get_absolute_file_path('6_1a.sce')
filename=pathname+filesep()+'6_1a_data.sci'
exec(filename)
clf();
i = 1;
Cl = 0;Cd = 0;Cl_Cd =0;Thrust = 0;
while(i<=length(V))
    Cl(i) = 2*W/(D*S*V(i)^2);
    Cd(i) = Cdo + Cl(i)^2/(%pi*e*AR);
    Cl_Cd(i) = Cl(i)/Cd(i);
    Thrust(i) = W/Cl_Cd(i)/1000;
   i = i+1;
end
xlabel("Velocity (m/s)");
ylabel("Thrust (kN)");
plot2d(V,Thrust,3);
```

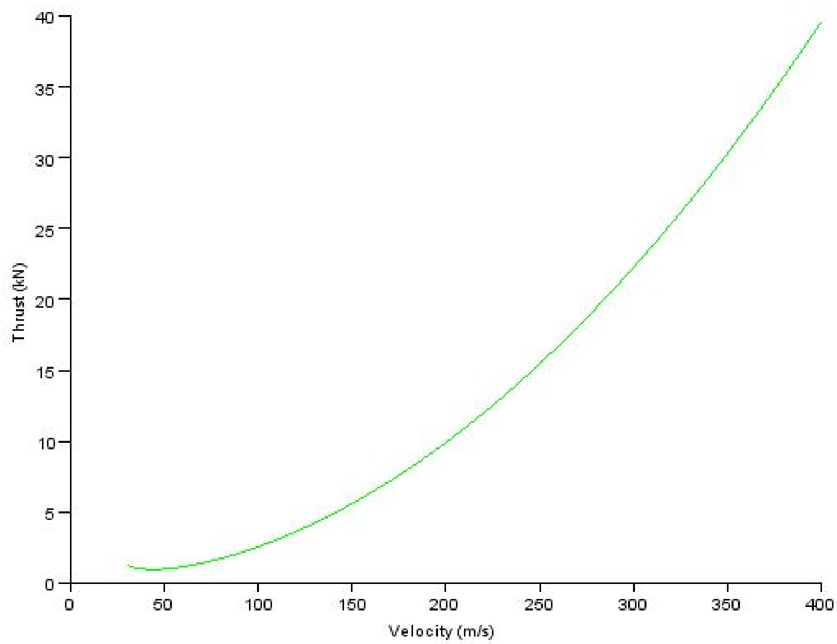

Figure 6.1: Example 1 a

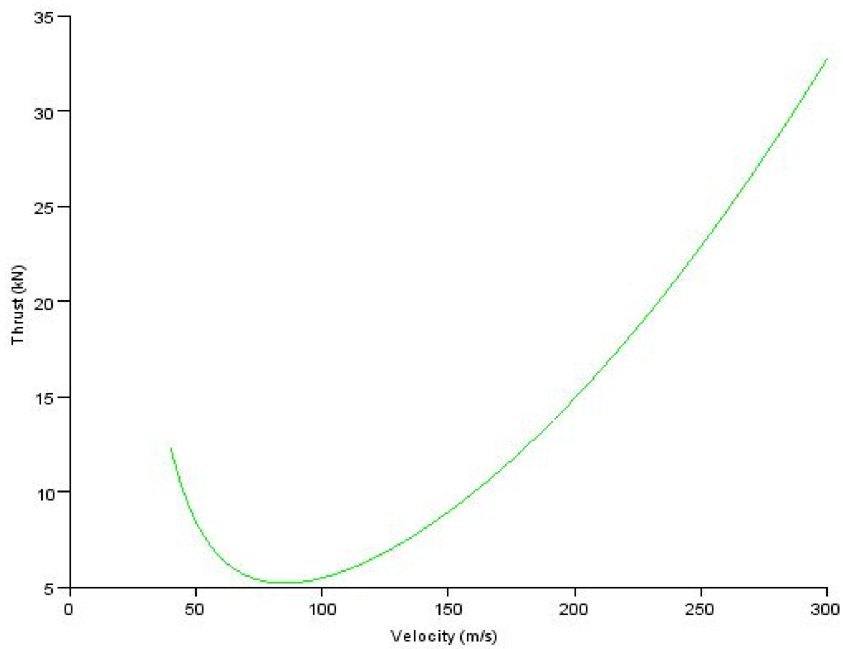

Figure 6.2: Example 1 b

check Appendix AP 42 for dependency:

6_1a_data.sci

Scilab code Exa 6.1.b Example 1 b

```
pathname=get_absolute_file_path('6_1b.sce')
filename=pathname+filesep()+'6_1b_data.sci'
exec(filename)
clf();
i = 1;
Cl = 0;Cd = 0;Cl_Cd =0;Thrust = 0;
```

```
while(i<=length(V))
    Cl(i) = 2*W/(D*S*V(i)^2);
    Cd(i) = Cdo + Cl(i)^2/(%pi*e*AR);
    Cl_Cd(i) = Cl(i)/Cd(i);
    Thrust(i) = W/Cl_Cd(i)/1000;
   i = i+1;
end
xlabel("Velocity (m/s)");
ylabel("Thrust (kN)");
plot2d(V,Thrust,3);
```

check Appendix AP 41 for dependency:

`6_1b_data.sci`

check Appendix AP 30 for dependency:

`602data.sci`

Scilab code Exa 6.2 Example 2

```
pathname=get_absolute_file_path('602.sce')
filename=pathname+filesep()+'602data.sci'
exec(filename)
clf();
i = 1;
Cl = 0;Cd = 0;Cl_Cd =0;Thrust = 0;
while(i<=length(V))
    Cl(i) = 2*W/(D*S*V(i)^2);
    Cd(i) = Cdo + Cl(i)^2/(%pi*e*AR);
    Cl_Cd(i) = Cl(i)/Cd(i);
    Thrust(i) = W/Cl_Cd(i)/1000;
    Tf(i)=2*16245/1000;
   i = i+1;
end
```

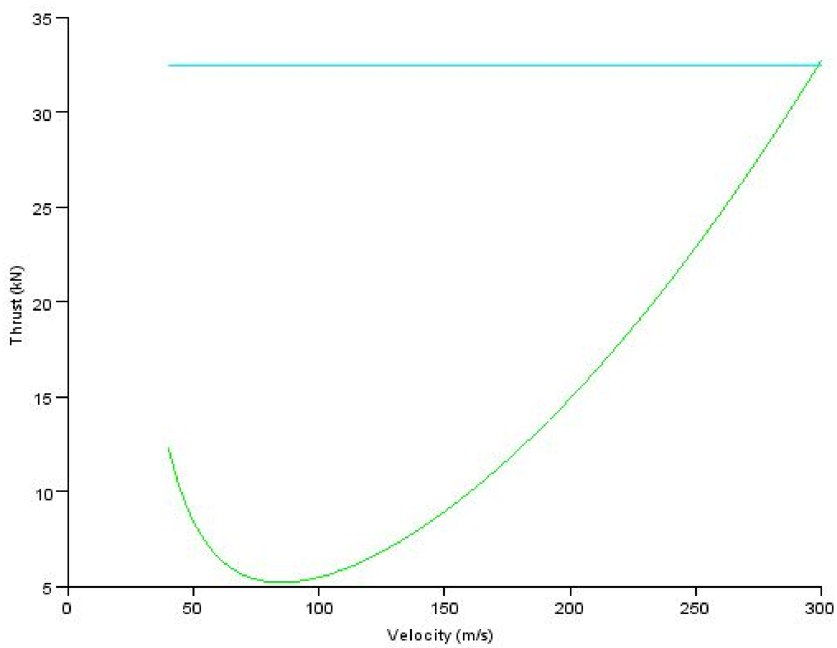

Figure 6.3: Example 2

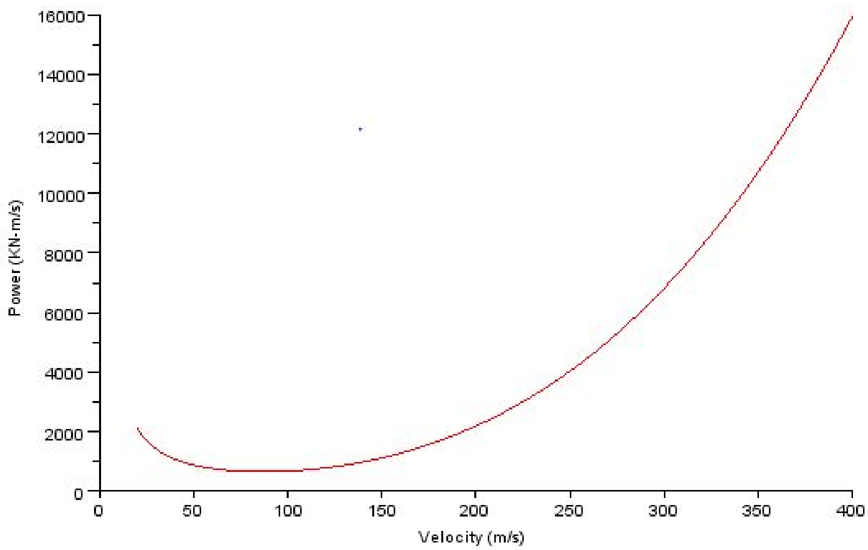

Figure 6.4: Example 3 a

```
xlabel("Velocity (m/s)");
ylabel("Thrust (kN)");
plot2d(V,Thrust,3);
plot2d(V,Tf,4);
disp("As Thrust required equals Thrust provided by
    two turbofan at Velocity 297 m/s approx(
    intersection point of both graphs.)so it will be
    Vmax")
Vmax=297;
printf("\Answer:\n")
printf("\n\maximum velocity: %f m/s\n\n",Vmax)
```

Scilab code Exa 6.3.a Example 3 a

```
pathname=get_absolute_file_path('6_3a.sce')
filename=pathname+filesep()+'6_3a_data.sci'
exec(filename)
clf();
i = 1;
Cl = 0;Cd = 0;Cl_Cd =0;Thrust = 0;
while(i<=length(V))
    Cl(i) = 2*W/(D*S*V(i)^2);
    Cd(i) = Cdo + Cl(i)^2/(%pi*e*AR);
    Cl_Cd(i) = Cl(i)/Cd(i);
    Thrust(i) = W/Cl_Cd(i)/1000;
    Power(i)=Thrust(i)*V(i);
   i = i+1;
end
xlabel("Velocity (m/s)");
ylabel("Power (KN-m/s)");
plot2d(V,Power,5);
```

check Appendix AP 28 for dependency:

`6_3a_data.sci`

Scilab code Exa 6.3.b Example 3 b

```
pathname=get_absolute_file_path('6_3b.sce')
filename=pathname+filesep()+'6_3b_data.sci'
exec(filename)
clf();
i = 1;
Cl = 0;Cd = 0;Cl_Cd =0;Thrust = 0;
while(i<=length(V))
    Cl(i) = 2*W/(D*S*V(i)^2);
    Cd(i) = Cdo + Cl(i)^2/(%pi*e*AR);
    Cl_Cd(i) = Cl(i)/Cd(i);
```

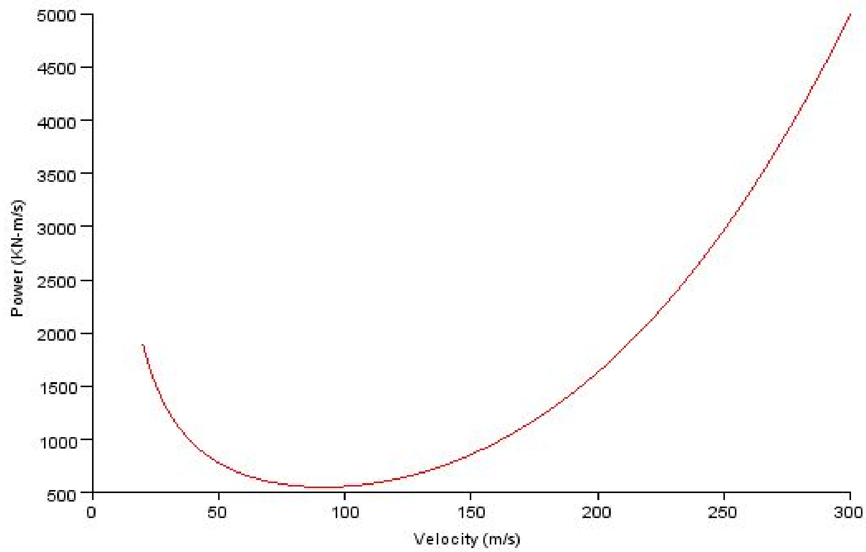

Figure 6.5: Example 3 b

```
    Thrust(i) = W/Cl_Cd(i)/1000;
    Power(i)=Thrust(i)*V(i)
   i = i+1;
end
xlabel("Velocity (m/s)");
ylabel("Power (KN-m/s)");
plot2d(V,Power,5);
```

check Appendix AP 27 for dependency:

`6_3b_data.sci`

Scilab code Exa 6.4.a Example 4 a

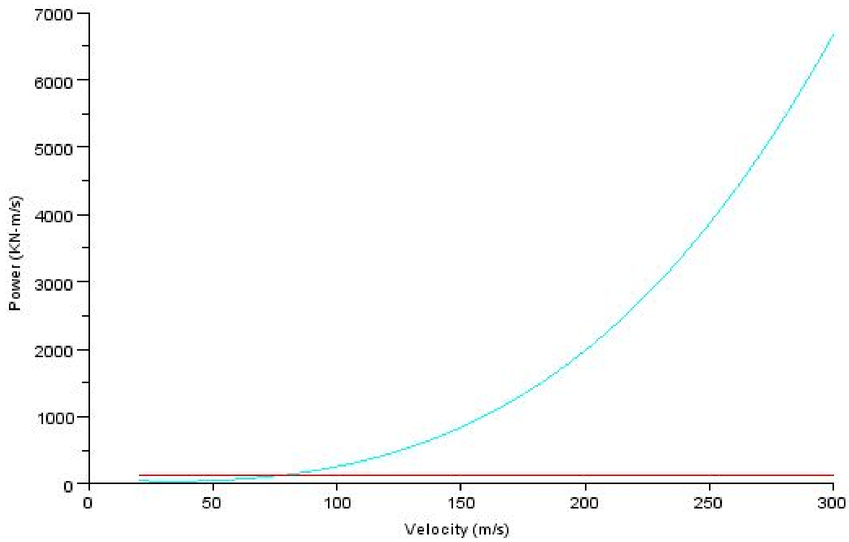

Figure 6.6: Example 4 a

```
pathname=get_absolute_file_path('6_4a.sce')
filename=pathname+filesep()+'6_4a_data.sci'
exec(filename)
clf();
V=linspace(20,300,500);
i = 1;
Cl = 0;Cd = 0;Cl_Cd =0;Thrust = 0;
while(i<=length(V))
    Cl(i) = 2*W/(D*S*V(i)^2);
    Cd(i) = Cdo + Cl(i)^2/(%pi*e*AR);
    Cl_Cd(i) = Cl(i)/Cd(i);
    Thrust(i) = W/Cl_Cd(i)/1000;
    Power(i)=Thrust(i)*V(i);
    Pa(i)=P*Pf*746/1000;
   i = i+1;
end
xlabel("Velocity (m/s)");
ylabel("Power (KN-m/s)");
```

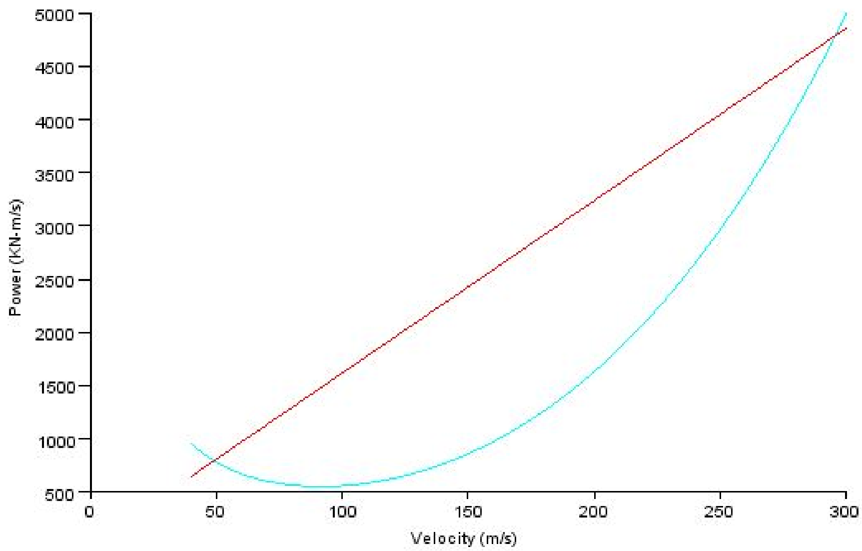

Figure 6.7: Example 4 b

```
plot2d(V,Power,4);
plot2d(V,Pa,5);
disp("the intersection of both graph shows maximum
    velocity of CP-1 at sea level which is arround 81
    m/s.")
```

check Appendix AP 26 for dependency:

`6_4a_data.sci`

Scilab code Exa 6.4.b Example 4 b

```
pathname=get_absolute_file_path('6_4b.sce')
filename=pathname+filesep()+'6_4b_data.sci'
exec(filename)
```

```
clf();
V=linspace(40,300,500);
i = 1;
Cl = 0;Cd = 0;Cl_Cd =0;Thrust = 0;
while(i<=length(V))
    Cl(i) = 2*W/(D*S*V(i)^2);
    Cd(i) = Cdo + Cl(i)^2/(%pi*e*AR);
    Cl_Cd(i) = Cl(i)/Cd(i);
    Thrust(i) = W/Cl_Cd(i)/1000;//unit KN
    Power(i)=Thrust(i)*V(i)//unit KN-m/s
    Pa(i)=D*Tf*V(i)/(Do*1000);//power(KN-m/s) at height 6706.5 m corresponding to velocity
   i = i+1;
end
xlabel("Velocity (m/s)");
ylabel("Power (KN-m/s)");
plot2d(V,Power,4);
plot2d(V,Pa,5);
disp("As we can see the higher intersection point of both curve is arround 294m/s(approx),which is the maximum velocity for CJ-1 at 6705.6 meter.")
```

check Appendix AP 25 for dependency:

`6_4b_data.sci`

check Appendix AP 24 for dependency:

`6_05data.sci`

Scilab code Exa 6.5 Example 5

```
pathname=get_absolute_file_path('6_05.sce')
filename=pathname+filesep()+'6_05data.sci'
exec(filename)
```

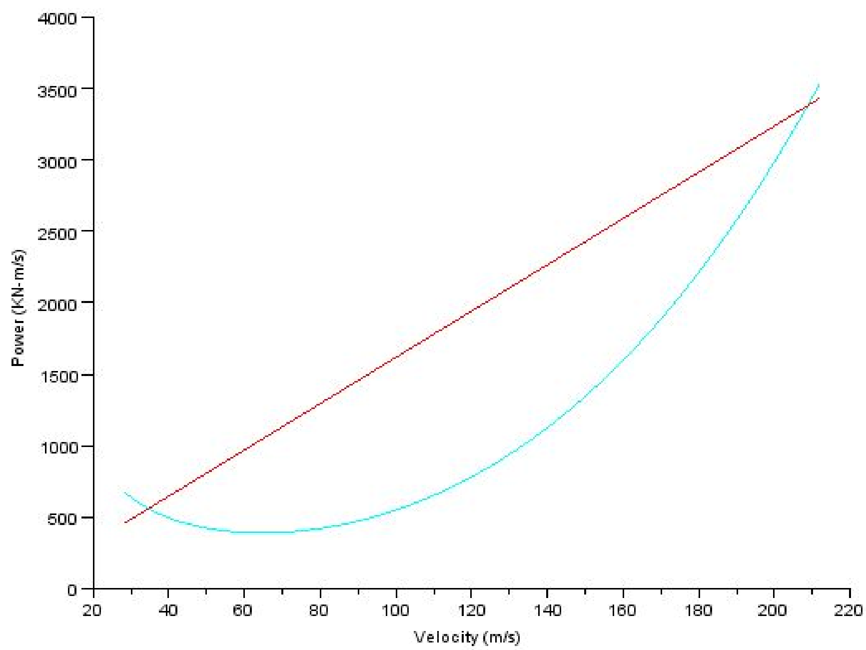

Figure 6.8: Example 5

```
clf();
V=linspace(40,300,500);
i = 1;
Cl = 0;Cd = 0;Cl_Cd =0;Thrust = 0;Vo=0;
while(i<=length(V))
    Cl(i) = 2*W/(D*S*V(i)^2);
    Cd(i) = Cdo + Cl(i)^2/(%pi*e*AR);
    Cl_Cd(i) = Cl(i)/Cd(i);
    Vo(i)=V(i)*(D/Do)^0.5;//corresponding velocity points at sea level
    Thrust(i) = W/Cl_Cd(i)/1000;//unit KN
    Power(i)=Thrust(i)*Vo(i)//unit KN-m/s
    Pa(i)=D*Tf*Vo(i)/(Do*1000);//power(KN-m/s) at height 6706.5 m corresponding to velocity
      i = i+1;
end
xlabel("Velocity (m/s)");
ylabel("Power (KN-m/s)");
plot2d(Vo,Power,4);
plot2d(Vo,Pa,5)
printf("\nmaximum velocity for CJ-1 approx 210m/s(as seen from graph)")
```

check Appendix AP 23 for dependency:

`6_06data.sci`

Scilab code Exa 6.6 Example 6

```
pathname=get_absolute_file_path('6_06.sce')
filename=pathname+filesep()+'6_06data.sci'
exec(filename)
clf();

```

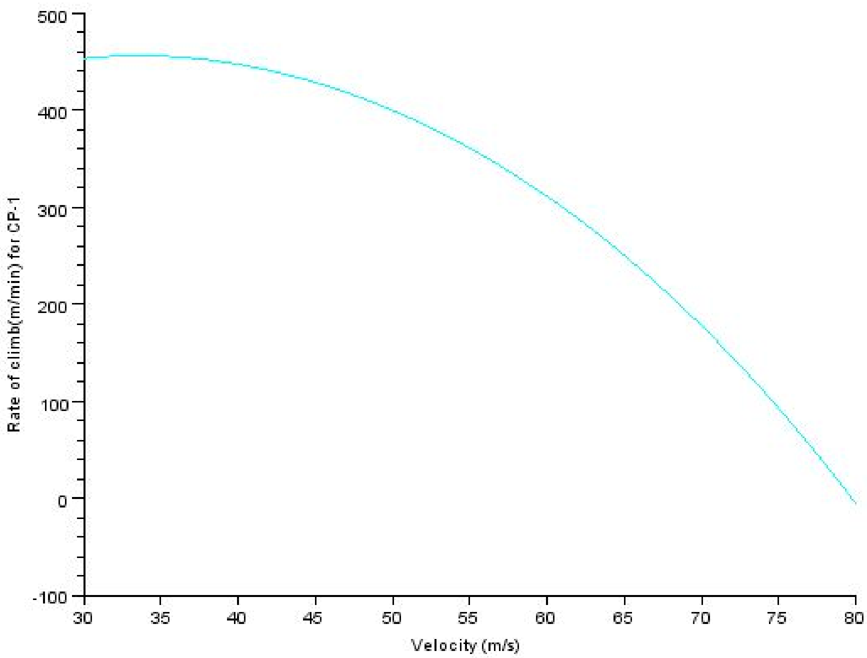

Figure 6.9: Example 6

```
i = 1;
Cl = 0;Cd = 0;Cl_Cd =0;Thrust = 0;
while(i<=length(V))
    Cl(i) = 2*W/(D*S*V(i)^2);
    Cd(i) = Cdo + Cl(i)^2/(%pi*e*AR);
    Cl_Cd(i) = Cl(i)/Cd(i);
    Thrust(i) = W/Cl_Cd(i)/1000;
    Power(i)=Thrust(i)*V(i);
    R_C(i)=(Pa-Power(i))*1000*60/W;//rate of climb(R
       /C in meter per minute)
   i = i+1;
end
xlabel("Velocity (m/s)");
ylabel("Rate of climb(m/min) for CP-1");
plot2d(V,R_C,4);
```

check Appendix AP 22 for dependency:

6_07data.sci

Scilab code Exa 6.7 Example 7

```
pathname=get_absolute_file_path('6_07.sce')
filename=pathname+filesep()+'6_07data.sci'
exec(filename)
a=atand(1/L_D);disp(a,"a=","tan(a)=1/(L/D)","minimum
    glide angle a:")
R=H*L_D;disp(R,"R=","R=H*L/D","maximum range along
   ground :")
printf("\Answer:\n")
printf("\minimum glide angle: %f \n",a)
printf("\n\maximum range covered along ground: %f m\
   n\n",R)
```

check Appendix AP 21 for dependency:

6_08data.sci

Scilab code Exa 6.8 Example 8

```
pathname=get_absolute_file_path('6_08.sce')
filename=pathname+filesep()+'6_08data.sci'
exec(filename)
a=atand(1/L_D);disp(a,"a=","tan(a)=1/(L/D)","minimum
    glide angle a:")
R=H*L_D;disp(R,"R=","R=H*L/D","maximum range along
   ground :")
printf("\Answer:\n")
printf("\minimum glide angle: %f degree\n",a)
printf("\n\maximum range covered along ground: %f m\
   n\n",R)
```

check Appendix AP 20 for dependency:

`6_09data.sci`

Scilab code Exa 6.9 Example 9

```
pathname=get_absolute_file_path('6_09.sce')
filename=pathname+filesep()+'6_09data.sci'
exec(filename)
V1=sqrt(2*Wl*cos(a)/(D1*Cl));disp(V1,"V1=","V1=sqrt
   (2*Wl*cos(a)/(D1*Cl))","For altitude 3048 meter:"
   )
V2=sqrt(2*Wl*cos(a)/(D2*Cl));disp(V2,"V2=","V2=sqrt
   (2*Wl*cos(a)/(D2*Cl))","For altitude 609.6 meter:
   ")
printf("\Answer:\n")
printf("\Velocity at equilibrium glide angle at 3048
    m: %f m/s\n",V1)
```

```
printf("\n\Velocity at equilibrium glide angle at 609.6 m: %f m/s\n\n",V2)
```

check Appendix AP 40 for dependency:

`6_12data.sci`

Scilab code Exa 6.12 Example 12

```
pathname=get_absolute_file_path('6_12.sce')
filename=pathname+filesep()+'6_12data.sci'
exec(filename)
clf();
V=linspace(20,120,500);
i = 1;
Cl = 0;Cd = 0;Cl_Cd =0;Thrust = 0;
while(i<=length(V))
    Cl(i) = 2*Wo/(D*S*V(i)^2);
    Cd(i) = Cdo + Cl(i)^2/(%pi*e*AR);
    Cl_Cd(i) = Cl(i)/Cd(i);
    Cl1_Cd(i)=Cl(i)^1.5/Cd(i)
   i = i+1;
end
xlabel("Velocity (m/s)");
plot2d(V,Cl_Cd,3);
plot2d(V,Cl1_Cd,4);
//from graph we can see:
Cl_Cdmax=13.62;//maximum Cl/Cd
Cl1_Cdmax=12.81;//maximum Cl^1.5/Cd
R=(n/c)*Cl_Cdmax*log(Wo/W1)
disp(R,"R=","Range R=(n/c)*(Cl/Cd)*log(Wo/W1)")
E=(n/c)*Cl1_Cdmax*sqrt(2*D*S)*[1/sqrt(W1)-1/sqrt(Wo)
    ]
disp(E,"E=","Endurance E=(n/c)*(Cl^1.5/Cd)*sqrt(2*D*
    S)*[1/sqrt(W1)-1/sqrt(Wo)]")
printf("\Answer:\n")
```

```
printf("\n\Maximum range of CP-1: %f m\n\n",R)
printf("\n\Maximum Endurance of CP-1: %f s\n\n",E)
```

check Appendix AP 39 for dependency:

`6_13data.sci`

Scilab code Exa 6.13 Example 13

```
pathname=get_absolute_file_path('6_13.sce')
filename=pathname+filesep()+'6_13data.sci'
exec(filename)
clf();
V=linspace(20,400,500);
i = 1;
Cl = 0;Cd = 0;Cl_Cd =0;Thrust = 0;
while(i<=length(V))
    Cl(i) = 2*Wo/(D*S*V(i)^2);
    Cd(i) = Cdo + Cl(i)^2/(%pi*e*AR);
    Cl_Cd(i) = Cl(i)/Cd(i);
    Cl1_Cd(i)=Cl(i)^0.5/Cd(i)
   i = i+1;
end
xlabel("Velocity (m/s)");
plot2d(V,Cl_Cd,3);
plot2d(V,Cl1_Cd,4);
//from graph we can see:
Cl_Cdmax=16.9;//maximum Cl/Cd
Cl1_Cdmax=23.4;//maximum Cl^0.5/Cd
R=[sqrt(Wo)-sqrt(W1)]*Cl1_Cdmax*2*(sqrt(2/(D*S))/c);
disp(R,"R=","Range R=[sqrt(Wo)-sqrt(W1)]*Cl^.5/Cd
    *2*(sqrt(2/(D*S))/c)")
E=(Cl_Cdmax*log(Wo/W1))/c;
disp(E,"E=","Endurance E=(Cl_Cdmax*log(Wo/W1))/c")
printf("\Answer:\n")
printf("\n\Maximum range of CJ-1: %f m\n\n",R)
```

```
printf("\n\Maximum Endurance of CJ-1: %f s\n\n",E)
```

check Appendix AP 38 for dependency:

6_14data.sci

Scilab code Exa 6.14 Example 14

```
pathname=get_absolute_file_path('6_14.sce')
filename=pathname+filesep()+'6_14data.sci'
exec(filename)
Cl_Cdmax=sqrt(Cdo*%pi*e*AR)/(2*Cdo);
disp(Cl_Cdmax,"(Cl/Cd)max=","(Cl/Cd)max=sqrt(Cdo*%pi
    *e*AR)/(2*Cdo)")
Cl_Cd1max=(3*Cdo*%pi*e*AR)^(3/4)/(4*Cdo);
disp(Cl_Cd1max,"((Cl/Cd)^1.5)max=","((Cl/Cd)^1.5)max
    =(3*Cdo*%pi*e*AR)^(3/4)/(4*Cdo)")
```

check Appendix AP 37 for dependency:

6_15data.sci

Scilab code Exa 6.15 Example 15

```
pathname=get_absolute_file_path('6_15.sce')
filename=pathname+filesep()+'6_15data.sci'
exec(filename)
Cl_Cdmax=sqrt(Cdo*%pi*e*AR)/(2*Cdo);
disp(Cl_Cdmax,"(Cl/Cd)max=","(Cl/Cd)max=sqrt(Cdo*%pi
    *e*AR)/(2*Cdo)")
Cl_Cd1max=((1/3)*Cdo*%pi*e*AR)^(1/4)/(4*Cdo/3);
disp(Cl_Cd1max,"(Cl^0.5/Cd)max=","(Cl^0.5/Cd)max
    =((1/3)*Cdo*%pi*e*AR)^(1/4)/(4*Cdo/3)")
```

Scilab code Exa 6.16.b `Example 16 b`

```
pathname=get_absolute_file_path('6_16b.sce')
filename=pathname+filesep()+'6_16b_data.sci'
exec(filename)
R_Cmax=(Pf*P*746/W)-0.8776*sqrt(W/(D*S*Cdo))*(1/(
    L_Dmax)^1.5)//(R/C)max
printf("\Answer:\n")
printf("\n\Maximum Rate of climd for CP-1: %f m/s\n\
    n",R_Cmax)
```

check Appendix AP 36 for dependency:

`6_16b_data.sci`

Scilab code Exa 6.16.c `Example 16 c`

```
pathname=get_absolute_file_path('6_16c.sce')
filename=pathname+filesep()+'6_16c_data.sci'
exec(filename)
A=2*Tf/W;B=W/S;C=1/L_Dmax^2;E=sqrt(A^2-C)
Vmax=sqrt((A*B+B*E)/(D*Cdo))
printf("\Answer:\n")
printf("\n\Maximum Velocity for CJ-1: %f m/s\n\n",
    Vmax)
```

check Appendix AP 35 for dependency:

`6_16c_data.sci`

Scilab code Exa 6.16.d `Example 16 d`

```
pathname=get_absolute_file_path('6_16d.sce')
filename=pathname+filesep()+'6_16d_data.sci'
exec(filename)
Z=1+sqrt(1+(3/((L_Dmax)^2*(2*Tf/W)^2)))
R_Cmax=sqrt(W*Z/(3*D*Cdo*S))*(2*Tf/W)^1.5*[1-(Z/6)
    -(1.5/(Z*(2*Tf/W)^2*(L_Dmax)^2))]
printf("\Answer:\n")
printf("\n\Maximum Rate of Climb for CJ-1: %f m/s\n\
    n",R_Cmax)
```

check Appendix AP 34 for dependency:

`6_16d_data.sci`

check Appendix AP 33 for dependency:

`6_17data.sci`

Scilab code Exa 6.17 Example 17

```
pathname=get_absolute_file_path('6_17.sce')
filename=pathname+filesep()+'6_17data.sci'
exec(filename)
Sl=1.44*W^2/(g*D*S*Cl*[T-(Dr+Ur*(W-L))]);;disp(Sl,"
    Sl=","Sl=1.44*W^2/(g*D*S*Cl*[T-(Dr+Ur*(W-L))])","
    Liftoff distance Sl:")
printf("\Answer:\n")
printf("\n\Liftoff distance for the CJ-1 at se level
    : %f m\n\n",Sl)
```

check Appendix AP 32 for dependency:

`6_18data.sci`

Scilab code Exa 6.18 Example 18

```
pathname=get_absolute_file_path('6_18.sce')
filename=pathname+filesep()+'6_18data.sci'
exec(filename)
Sl=(Vt^2*W)/(2*g*(Dr+Ur*W));disp(Sl,"Sl=","Sl=(Vt^2*
   W)/(2*g*(Dr+Ur*W))","landing ground roll distance
    Sl:")
printf("\Answer:\n")
printf("\n\Landing ground roll distance at sea level
   : %f m\n\n",Sl)
```

Scilab code Exa 6.19.a Example 19 a

```
pathname=get_absolute_file_path('6_19a.sce')
filename=pathname+filesep()+'6_19data.sci'
exec(filename)
A=D*S*Cdo/2;
B=2*Wo^2/(D*S*%pi*e*AR);
V=poly(0,'V');
p=Pa*V-A*V^4-B
disp(roots(p),"Roots of Polynomial p:",p,"p=","
   Polynomial p:")
disp("As we can see the maximum positive root is
   81.01 (approx), which is the maximum velocity at
   sea level of the UAV.")
```

check Appendix AP 31 for dependency:

`6_19data.sci`

Scilab code Exa 6.19.b Example 19 b

```
pathname=get_absolute_file_path('6_19b.sce')
filename=pathname+filesep()+'6_19data.sci'
```

```
exec(filename)
disp("(R/C)max=(P/W)max-0.8776*sqrt(W/(S*D*Cdo))*(Cd
   /Cl)^1.5")
A=Pa/Wo;
Cd_Cl=2*Cdo/sqrt(Cdo*%pi*e*AR);//ratio , Cd/Cl
B=0.8776*sqrt(Wo/(S*D*Cdo))*(Cd_Cl)^1.5;
R_Cmax=A-B;//maximum rate of climb
printf("\Answer:\n")
printf("\n\maximum rate of climb at sea level: %f m/
   s\n\n",R_Cmax)
```

check Appendix AP 31 for dependency:

`6_19data.sci`

Scilab code Exa 6.19.c Example 19 c

```
pathname=get_absolute_file_path('6_19c.sce')
filename=pathname+filesep()+'6_19data.sci'
exec(filename)
Cl_Cd=sqrt(Cdo*%pi*e*AR)/(2*Cdo);//ratio(Cl/Cd)
disp(Cl_Cd)
R=(n/c)*Cl_Cd*log(Wo/(W-W1))*0.62137*10^-3 ;//range
   in miles
printf("\Answer:\n")
printf("\n\maximum range: %f miles\n\n",R)
```

check Appendix AP 31 for dependency:

`6_19data.sci`

Scilab code Exa 6.19.d Example 19 d

```
pathname=get_absolute_file_path('6_19d.sce')
filename=pathname+filesep()+'6_19data.sci'
exec(filename)
E=(n/(4*c*Cdo))*(3*Cdo*%pi*e*AR)^(3/4)*sqrt(2*D*S)*[1/sqrt(W-W1)-1/sqrt(Wo)]
printf("\Answer:\n")
printf("\n\Maximum Endurance at sea level: %f s\n\n",E)
```

check Appendix AP 31 for dependency:

`6_19data.sci`

check Appendix AP 29 for dependency:

`6_20data.sci`

Scilab code Exa 6.20 Example 20

```
pathname=get_absolute_file_path('6.20.sce')
filename=pathname+filesep()+'6.20data.sci'
exec(filename)
R1_R2=sqrt((n2^2-1)/(n1^2-1));//ratio(R1/R2)
disp(R1_R2,"ratio of turn radius :R1/R2=sqrt((n2^2-1)/(n1^2-1))")
w1_w2=sqrt((n1^2-1)/(n2^2-1));//ratio(w1/w2)
disp(w1_w2,"ratio of turn rate :w1/w2=sqrt((n1^2-1)/(n2^2-1))")
printf("\Answer:\n")
printf("\n\Ratio of turn radius: %f \n\n",R1_R2)
printf("\n\Ratio of turn rate: %f m/s\n\n",w1_w2)
```

Chapter 7

Principles of Stability and Control

Scilab code Exa 7.1 Example 1

```
funcprot(0);
function[y] = f(x,y)
    z = poly(0,'z');
    y = x^2+y^2+ z^2;
endfunction
ans= derivat(f(1,1)); // finding derivative with
   respect to z at some point x,y;
disp(ans,"derivative of x^2+y^2+ z^2 with respect to
    z:");
```

check Appendix AP 19 for dependency:

`7_02data.sci`

Scilab code Exa 7.2 Example 2

```
pathname=get_absolute_file_path('7_02.sce')
```

```
filename=pathname+filesep()+'7_02data.sci'
exec(filename)
Cmcg=Cmac+Clwb*(dh);disp(Cmcg,"Cmcg","Cmcg=Cmac+Clwb
    (dh)","moment coefficient about center of gravity
     Cmcg")
printf("\Answer:\n")
printf("\n\moment coefficient about center of
    gravity : %f \n\n",Cmcg)
```

check Appendix AP 18 for dependency:

`7_03data.sci`

Scilab code Exa 7.3 Example 3

```
pathname=get_absolute_file_path('7_03.sce')
filename=pathname+filesep()+'7_03data.sci'
exec(filename)
A=[1,Awb*ab2;1,Awb*ab3];
B=[1,1];//coefficient of moment coefficient about
    aerodynamic center
C=[Awb*ab2,Awb*ab3];//coefficient of h-hac
D=[-0.01,0.05];
dh=det([B;D])/det(A);//difference between location
    of aerodynamic center and center of gravity
hac=h-dh;
Cmac=det([D;C])/det(A)//moment coefficient about
    aerodynamic center
printf("\Answer:\n")
printf("\n\Location of aerodynamic center: %f\n\n",
    hac)
printf("\n\moment coefficient about aerodynamic
    center of wing-body : %f\n\n",Cmac)
```

check Appendix AP 17 for dependency:

`7_04data.sci`

Scilab code Exa 7.4 Example 4

```
pathname=get_absolute_file_path('7_04.sce')
filename=pathname+filesep()+'7_04data.sci'
exec(filename)
Cmcg=Cmac+a*a1*(dh-Vh*at*(1-de)/a)+Vh*at*(It+eo)
disp(Cmcg,"Cmcg=","Cmcg=Cmac+a*a1*(dh-Vh*at(1-de)/a)
    +Vh*at*(It+eo)","moment coefficient about COG
    Cmcg:")
printf("\Answer:\n")
printf("\n\moment coefficient about center of
    gravity : %f \n\n",Cmcg)
```

check Appendix AP 16 for dependency:

`7_05data.sci`

Scilab code Exa 7.5 Example 5

```
pathname=get_absolute_file_path('7_05.sce')
filename=pathname+filesep()+'7_05data.sci'
exec(filename)
disp("->as slope (DCmg) of moment coefficient curve
    is negative the airplane model is statically
    stable.")
disp("->as equilibrium angle of attack (Ae) falls in
    a reasonable range, the plane is longitudinally
    stable.")
```

check Appendix AP 15 for dependency:

`7_06data.sci`

Scilab code Exa 7.6 Example 6

```
pathname=get_absolute_file_path('7_06.sce')
filename=pathname+filesep()+'7_06data.sci'
exec(filename)
Hn=Hac+Vh*at*(1-de)/a;
disp(Hn,"Hn=","Hn=Hac+Vh*at*(1-de)/a","neutral point
    location Hn:")
printf("\Answer:\n")
printf("\n\Neutral point location : %f \n\n",Hn)
```

check Appendix AP 14 for dependency:

`7_07data.sci`

Scilab code Exa 7.7 Example 7

```
pathname=get_absolute_file_path('7_07.sce')
filename=pathname+filesep()+'7_07data.sci'
exec(filename)
Sm=Hn-h;disp(Sm,"Sm=","Sm=Hn-h","static margin Sm:")
printf("\Answer:\n")
printf("\n\Static Margin : %f \n\n",Sm)
```

check Appendix AP 13 for dependency:

`7_08data.sci`

Scilab code Exa 7.8 Example 8

```
pathname=get_absolute_file_path('7_08.sce')
filename=pathname+filesep()+'7_08data.sci'
exec(filename)
Dtrm=(Cmo+DCmcg*a1)/(Vh*DClt);
disp(Dtrm,"Dtrm=","Dtrm=(Cmo+DCmg*a1)/(Vh*DClt)","
   elevator deflection angle Dtrm::")
printf("\Answer:\n")
printf("\n\To trim the airplane at an angle of
   attack of 6.5 degree the elevator must be
   deflected upward(negative) by : %f degree\n\n",
   Dtrm)
```

check Appendix AP 12 for dependency:

`7_09data.sci`

Scilab code Exa 7.9 Example 9

```
pathname=get_absolute_file_path('7_09.sce')
filename=pathname+filesep()+'7_09data.sci'
exec(filename)
disp("for stick fixed condition neutral point is at
   0.516(from example 7.6) but for stick free
   condition it is approx 0.448,hence moving forward
    and decreasing the stability")
```

Chapter 8

Space Flight

check Appendix AP 11 for dependency:

`8_01data.sci`

Scilab code Exa 8.1 Example 1

```
pathname=get_absolute_file_path('8_01.sce')
filename=pathname+filesep()+'8_01data.sci'
exec(filename)
h=Rb*V*cos(alpha);disp(h,"h=","h=Rb*V*cos(alpha)")
P=h^2/K;disp(P,"P=")
e=sqrt(1+2*(h^2/K^2)*((V^2/2)-(K/Rb)));disp(e,"e=","e=sqrt(1+2*(h^2/K^2)*((V^2/2)-(K/Rb)))")
C=-acosd((P/Rb-1)/e);
disp(C,"C=","C=-acosd((P/Rb-1)/e)");
disp("equals approx 1.056*10^7/(1+0.4654*cos(theta+9.46))","P/(1+e*cos(theta-C))","From the above values we can see equation of trajectory :")
```

check Appendix AP 10 for dependency:

`8_02data.sci`

Scilab code Exa 8.2 Example 2

```
pathname=get_absolute_file_path('8_02.sce')
filename=pathname+filesep()+'8_02data.sci'
exec(filename)
T2=T1*(a2/a1)^1.5;
disp(T2,"T2=","T2=T1*(a2/a1)^1.5","period of mars T2 from keplers third law:")
printf("\Answer:\n")
printf("\n\Period of mars: %f days\n\n",T2)
```

check Appendix AP 9 for dependency:

`8_03data.sci`

Scilab code Exa 8.3 Example 3

```
pathname=get_absolute_file_path('8_03.sce')
filename=pathname+filesep()+'8_03data.sci'
exec(filename)
h=-log(D/Do)/Z;disp(h,"h=","h=-ln(D/Do)/Z","altitude of maximum decelation h:")
Amax=Ve^2*Z*sin(theta)/(2*%e);disp(Amax,"Amax=","Amax=V^2*Z*sin(theta)/(2*%e)","value of maximum deceleration Amax")
V=Ve*%e^(-Do/(2*B*Z*sin(theta)));disp(V,"V=","V=Ve*%e^(-Do/(2*B*Z*sin(theta)))","velocity at impact on earth surface")
printf("\Answer:\n")
printf("\n\altitude at which maximum deceleration occur: %f m\n\n",h)
printf("\n\value of maximum deceleration: %f m/s^2\n\n",Amax)
printf("\n\velocity at impact on earth surface: %f m/s\n\n",V)
```

Chapter 9

Propulsion

check Appendix AP 8 for dependency:

```
9_01data.sci
```

Scilab code Exa 9.1 Example 1

```
pathname=get_absolute_file_path('9_01.sce')
filename=pathname+filesep()+'9_01data.sci'
exec(filename)
x=poly(0,'x');
P=x-10*x+9.5;
t=roots(P);
V2=%pi*b^2*(Stroke+t)*(10^-6)/4;disp(V2,"V2=%pi*b^2*(Stroke+t)/4");
V3=V2/r;disp(V3,"V3=V2/r");
V5=V2;V4=V3;
Wcomp=(P2*V2-P3*V3)/(1-y);
disp(Wcomp,"Wcomp=","Wcomp=P2*V2-P3*V3/(1-y);","work done in compression cycle Wcomp:")
Wpower=(P5*V5-P4*V4)/(1-y);
disp(Wpower,"Wpower=","Wpower=P5*V5-P4*V4/(1-y);","work done in power stroke Wpower:")
Pa=6*n*nm*(rpm)*(Wpower-Wcomp)/120;
```

```
disp(Pa,"Pa=n*nm*(rpm)*(Wpower-Wcomp)/120","power
  available Pa:")
printf("\Answer:\n")
printf("\n\Power available from the engine propeller
   combination: %f J/s \n\n",Pa)
```

check Appendix AP 7 for dependency:

`9_02data.sci`

Scilab code Exa 9.2 Example 2

```
pathname=get_absolute_file_path('9_02.sce')
filename=pathname+filesep()+'9_02data.sci'
exec(filename)
Pe=Pa*120/(n*Nmech*rpm*d);
disp(Pe,"Pe=","Pe=Pa*120/(n*Nmech*rpm*d)","mean
  effective pressure Pe:")
printf("\Answer:\n")
printf("\n\Mean effective pressure : %f N/m^2\n\n",
  Pe)
```

check Appendix AP 6 for dependency:

`9_03data.sci`

Scilab code Exa 9.3 Example 3

```
pathname=get_absolute_file_path('9_03.sce')
filename=pathname+filesep()+'9_03data.sci'
exec(filename)
T=Mdot*(Ve-V)+(Pe-P)*Ae;
disp(T,"T=","T=Mdot*(Ve-V)+(Pe-P)*Ae","Thrust of the
   turbojet T:")
```

```
printf("\Answer:\n")
printf("\n\Mean effective pressure : %f N\n\n",T)
```

check Appendix AP 5 for dependency:

9_04data.sci

Scilab code Exa 9.4 Example 4

```
pathname=get_absolute_file_path('9_04.sce')
filename=pathname+filesep()+'9_04data.sci'
exec(filename)
T=Mdot*Ve;disp(T,"T=","T=Mdot*Ve","As Pe equals
    ambient pressure at 30 Km Thrust T:")
Ae=Mdot/(De*Ve);disp(Ae,"Ae=","Ae=Mdot/(De*Ve)","
    exit area Ae:")
Me=Ve/sqrt(y*R*Te);disp(Me,"Me=","Me=Ve/sqrt(y*R*T)"
    ,"exit Mach No. Me:")
printf("\Answer:\n")
printf("\n\Specific impulse : %f s\n\n",Isp)
printf("\n\Thrust: %f N\n\n",T)
printf("\n\Area of the exit: %f m^2\n\n",Ae)
printf("\n\flow mach no at exit : %f \n\n",Me)
```

check Appendix AP 4 for dependency:

9_05data.sci

Scilab code Exa 9.5 Example 5

```
pathname=get_absolute_file_path('9_05.sce')
filename=pathname+filesep()+'9_05data.sci'
exec(filename)
```

```
printf("\n\burnout velocity of single stage rocket :
    %f m/s\n\n",Vb)
printf("\n\burnout velocity of double stage rocket
   after second stage: %f m/s\n\n",Vb2)
disp("As we can see from final burnout velocities
   that a double-stage rocket can give a greater
   launching velocity as compared to single stage
   rocket." )
```

Chapter 10

Flight Vehicle Structure and Material

check Appendix AP 3 for dependency:

`10_01data.sci`

Scilab code Exa 10.1 Example 1

```
pathname=get_absolute_file_path('10_01.sce')
filename=pathname+filesep()+'10_01data.sci'
exec(filename)
dl=strain*l;disp(dl,"dl=","dl=strain*l","elongation
    of the rod dl:")
printf("\Answer:\n")
printf("\n\elongation of the rod under this load: %f
    m\n\n",dl)
```

check Appendix AP 2 for dependency:

`10_02data.sci`

Scilab code Exa 10.2 Example 2

```
pathname=get_absolute_file_path('10_02.sce')
filename=pathname+filesep()+'10_02data.sci'
exec(filename)
disp("as the applied stress (approx 3513) bar is
   greater than yield stress but less than ultimate
   stress of the aluminium rod,it will experience
   permanent set but will not fracture" )
```

Chapter 11

Hypersonic Vehicles

check Appendix AP 1 for dependency:

`11_01data.sci`

Scilab code Exa 11.1 Example 1

```
pathname=get_absolute_file_path('11_01.sce')
filename=pathname+filesep()+'11_01data.sci'
exec(filename)
Cp=Cpmax*(sin(theta))^2;
disp(Cp,"Cp=","Cp=Cpmax*(sin(theta))^2","pressure
   coefficient at point 1 Cp:")
printf("\Answer:\n")
printf("\n\pressure coefficient at point 1 : %f \n\n
   ",Cp)
```

Appendix

Scilab code AP 1 Example 11.01data

```
//Refer to figure 11.1.
M=25;//mach no. of the flow
//let s denote  distance along the sphere surface and R radius than say s/R=r
r=0.6;//location of point 1 from stagnation point
phi=57.3*r //location of point 1 in degrees
theta=(90-phi)*%pi/180 //angle(in radian) made by the line tangent to the body at point 1 w.r.t free stream
y=1.4;//specific heat ratio of air
//let pressure behind the normal shock wave is Po2 and free stream pressure p.  Then Po2/P=Rp:
Rp=[(y+1)^2*M^2/(4*y*M^2-2*(y-1))]^(y/(y-1))*[(1-y+2*y*M^2)/(y+1)]
Cpmax=2*(Rp-1)/(y*M^2) //maximum pressure coefficient
```

Scilab code AP 2 Example 10.02data

```
//consider an aluminium rod.
D=6.35*10^-3;//diameter(meter) of the rod
T=11125;//Applied load(N) on the rod
Sty=3103;//yield tensile stress(bar)of aluminium rod
Stu=4206;//ultimate tensile stress(bar)of aluminium rod
sigma=T/(%pi*D^2*10^5/4) //tensile stress(bar) on
```

```
the rod
```

Scilab code AP 3 Example 10.01data

```
//consider a rod of stainless steel.
D=0.01905;//diameter(meter) of the rod
l=2.54;//length(meter) of the rod
T=53378.66;//Applied load(N) on the rod
Y=0.2*10^7;//young's modulous of the rod
sigma=T/(%pi*D^2*10^5/4) //tensile stress(bar) on the rod
//as the value of tensile stress is less than tensile yield stress Hook's law can be applied,so:
strain=sigma/Y //strain on the rod
```

Scilab code AP 4 Example 9.05data

```
Mt=5000;//total mass(Kg) for both the rocket
Isp=350;//specific impulse (s)for both rocket
g=9.8;
//for the single stage rocket:
Ms=500;//structural mass(Kg)
Mp=4450;//propellent mass(Kg)
Ml=50;//payload mass(Kg)
Mi=Ms+Mp+Ml;//initial mas(Kg)
Mf=Ms+Ml;//final mass(Kg)
Vb=g*Isp*log(Mi/Mf)//burnout velocity(m/s)
//for the double-stage Rocket
Ms1=400;//structural mass (Kg)of first stage
Mp1=3450;//propellent mass(Kg)of first stage
Ms2=100;//structural mass (Kg)of second stage
Mp2=1000;//propellent mass(Kg)of second stage
Ml=50;//payload mass(Kg)
Mi2=Ms1+Mp1+Ms2+Mp2+Ml;//initial mas(Kg)
Mf2=Ms1+Ms2+Ml;//final mass(Kg)
//burnout velocity(m/s) of the first stage:
Vb1=g*Isp*log((Mp1+Ms1+Mp2+Ms2+Ml)/(Ms1+Mp2+Ms2+Ml))
```

```
//increase in velocity by second stage DVb:
DVb=g*Isp*log((Mp2+Ms2+Ml)/(Ms2+Ml))
//velocity at burnout of second stage
Vb2=Vb1+DVb
```

Scilab code AP 5 Example 9.04data

```
//consider a rocket engine burning hydrogen and
    oxygen.
Po=25*1.01*10^5;//pressure at combustion chamber(N/m
    ^2)
To=3517;//temperature of combustion chamber(K)
A=0.1;//area of rocket nozzle(m^2)
Pe=1.1855*10^3;//exit pressure(N/m^2) at standard
    altitude of 30 Km
y=1.22;//specific heat ratio of the gas mixture
g=9.8;
M=16;//Molecular weight of gas mixture
Ru=8314;//universal gas constant(J/Kg.K)
R=8314/16 //specicific gas constant for this mixture
//specific impulse Isp:
Isp=sqrt(2*y*Ru*To*[1-(Pe/Po)^((y-1)/y)]/((y-1)*M))/
    g
//mass flow through engine(Kg/s):
Mdot=(Po*A/sqrt(To))*sqrt(y*(2/(y+1))^((y+1)/(y-1))
    /R)
Te=To*(Pe/Po)^((y-1)/y) //exit temperature in Kelvin
Cp=y*R/(y-1) //specific heat at constant pressure
    for the gas mixture
Ve=sqrt(2*Cp*(To-Te)) //velocity at exit of exhaust
    gas(m/s)
De=Pe/(R*Te) //exit density(Kg/m^3)
```

Scilab code AP 6 Example 9.03data

```
H=9144;//standard altitude at which airplane flying(
    meter)
```

```
P=0.3014*10^5;//pressure at standard altitude of
    9144 m(N/m^2)
D=0.459;//Density at standard altitude of 9144 m(Kg/
    m^3)
V=804.67*5/18 //free stream velocity(m/s)
Pe=0.3064*10^5;//pressure of exhaust gas at the exit
    (N/m^2)
Ve=487.68;//velocity of exhaust gas at exit(m/s)
Ai=0.65;//inlet area(m^2)
Ae=0.42;//exit area(m^2)
Mdot=D*V*Ai //mass flow through engine(Kg/s)
```

Scilab code AP 7 Example 9.02data

```
//consider the engine of example 9.1,datas are same
    as 9.1
Pa=1.034*10^4;//total power available(N/m^2)
n=0.83;//propeller efficiency
Nmech=0.75;//mechanical efficiency
rpm=3000;//for engine-propeller combination(
    revolution per minute)
b=9*10^-2;//bore(meter)
s=9.5*10^-2;//engine stroke
N=6;//number of cylinders
d=%pi*b^2*s*N/4 //displacement(meter)
```

Scilab code AP 8 Example 9.01data

```
//consider a six cylinder internal combustion engine
    .
y=1.4;//specific heat ratio for air
Stroke=9.5;//stroke (cm)of the internal combustion
    engine
b=9;//bore(cm)of the internal combustion engine
P2=0.8*1.01*10^5;//pressure (N/m^2)before
    compression stroke
T2=250;//temperature(k) before compression stroke
```

```
//V2 and V3 are volume before and after compression
    stroke respectively and V4 and V5 volume before
    and after power stroke respectively.
r=10;//compression ratio(V2/V3)
f=0.06;//fuel to air ratio by mass
P3=P2*r^y //pressure after compression stroke(
    isentropic condition)
T3=T2*r^(y-1)//temperature after compression stroke
//chemical energy released in 1 Kg gasoline is
    4.29*10^7 Joule so,heat released per Kg of fuel
    air mixture q equals:
q=4.29*10^7*0.06/1.06
Cv=720;//specific heat ratio(J/Kg-K)at constant
    volume for air
T4=q/Cv+T3 //temperature before power stroke
P4=P3*T4/T3 //pressure before power stroke
P5=P4*(1/r)^y //pressure after power stroke from
    isentropic relation
n=0.83;//propeller efficiency
nm=0.75;//mechanical efficiency
rpm=3000;//rotation per minute for the engine
```

Scilab code AP 9 Example 8.03data

```
Ve=13000;//velocity of solid iron sphere entering
    earth's atmosphere(m/s)
theta=15*%pi/180 //angle at which sphere is entering
r=0.5;//sphere radius(m)
Cd=1;//drag coefficient for a sphere at hypersonic
    speed
Ds=6963;//density of sphere(Kg/m^3)
g=9.8;//gravitational constant(m/s^2)
R=287;//gas constant for air(J/Kg.K)
Do=1.225;//density at sea level(Kg/m^3)
T=288;//assuming a constant temperature(k) for
    exponential universe
B=4*r*Ds/(3*Cd) //ballistic parameter(m/CD*S=4*r*Ds
    /(3*Cd))
```

```
Z=.000118
D=B*Z*sin(theta) //density at corresponding altitude
    of maximum deceleration
```

Scilab code AP 10 Example 8.02data

```
T1=365.256;//period of revolution of earth around
   sun(days)
a1=1.49527*10^11;//semimajor axis of earth's orbit(m
   )
a2=2.2783*10^11;//semimajor axis of Mars's orbit(m)
```

Scilab code AP 11 Example 8.01data

```
V=9000;//burnout velocity(m/s)
alpha=3*%pi/180;//direction of bernout velocity due
   north above local horizontal(degree)
H=.805*10^6;//altitude above sea level(meter)
beeta=27*%pi/180;//angle made by burnout point with
   equator
Re=6.4*10^6;//radius(m)of earth
Rb=7.2*10^6 //distance of bernout point from earth's
    center
K=3.986*10^14;//product of earth's mass and
   universal Gravitational constant.
```

Scilab code AP 12 Example 7.09data

```
//consider the airplane of example 7.8.its elevator
   hinge derivatives are:
DCh=-0.008;//derivative w.r.t absolute angle of
   attack of tail
DChe=-0.013;//derivative w.r.t elevator deflection
at=0.1;//tail lift slope per degree(from example
   7.4)
DClt=0.04;// elevator control efficiency (from
   example 7.8)
```

```
Hac=0.24;//location of aerodynamic center from
   leading edge(from example 7.3)
Vh=0.34;//tail volume ratio(from example 7.4)
de=0.35;//derivative of downwash angle w.r.t angle
   of attack(from example 7.4)
a=0.08;//lift slope(from example 7.4)
F=1-DClt*DCh/(at*DChe) //free elevator factor
Hn=Hac+F*Vh*at*(1-de)/a //neutral point
```

Scilab code AP 13 Example 7.08data

```
W=2.27*10^4;//weight of the airplane(N)
S=19;//wing area (m^2)
V=61;//velocity at sea level(m/s)
D=1.225;//density at sea level(Kg/m^3)
Cl=2*W/(D*S*V^2)  //lift coefficient
a=0.08;//lift slope per degree (from example 7.3)
a1=Cl/a //absolute angle of attack
DCmcg=-0.0133;//derivative of Cmcg w.r.t absolute
   angle of attack(from example 7.5)
Cmo=0.06;//value of moment coefficient at zero
   absolute angle of attack (from example 7.5)
Vh=0.34 //tail volume ratio(from example 7.4)
DClt=0.04;//elevator control efficiency
```

Scilab code AP 14 Example 7.07data

```
h=0.35;//location of center of gravity from leading
   edge
Hn=0.516;//Neutral point location
```

Scilab code AP 15 Example 7.06data

```
//consider wind tunnel model of example 7.3.datas
   are taken from example 7.3 and 7.4
Hac=0.24;//distance of aerodynamic center from
   leading edge
```

```
a=0.08;//lift slope
Vh=lt*St/(c*S)//tail volume ratio
at=0.1;//tail lift slope per degree
de=0.35;//derivative of downwash angle w.r.t angle of attack
```

Scilab code AP 16 `Example 7.05data`

```
//consider the wing−body−tail wind tunnel model of example 7.4.
a=0.08;//lift slope
S=0.1;//area of wing(m^2)
c=0.1;//chord of wing(m)
lt=0.17;//distance between airplane'scenter of gravity and aerodynamic center of tail
St=0.02;//tail area(m^2)
It=2.7;//tail settling area(degree)
at=0.1;//tail lift slope per degree
eo=0;//downwash angle at zero lift
de=0.35;//derivative of downwash angle w.r.t angle of attack
Vh=lt*St/(c*S)//tail volume ratio
Cmac=-0.032;//moment coefficient about the aerodynamic center
//derivative of Cmcg w.r.t absolute angle of attack:
DCmcg=a*(dh-Vh*at*(1-de)/a)
//value of moment coefficient at zero absolute angle of attack Cmo:
Cmo=Cmac+Vh*at*(It+eo)
//equilibrium angle of attack(from moment coefficient curve):
Ae=Cmo/0.0133
```

Scilab code AP 17 `Example 7.04data`

```
//consider the wing model of example 7.3:
S=0.1;//area of wing(m^2)
c=0.1;//chord of wing(m)
```

```
lt=0.17;//distance between airplane'scenter of gravity and aerodynamic center of tail
St=0.02;//tail area(m^2)
It=2.7;//tail settling area(degree)
at=0.1;//tail lift slope per degree
eo=0;//downwash angle at zero lift
de=0.35;//derivative of downwash angle w.r.t angle of attack
Vh=lt*St/(c*S)//tail volume ratio
//following datas are from example 7.3
Cmac=-0.032;//moment coefficient about the aerodynamic center
a=0.08;//lift slope
a1=7.88+1.5;//absolute angle of attack(degree)
dh=0.11;//distance between aerodynamic center and center of gravity
```

Scilab code AP 18 `Example 7.03data`

```
h=0.35;//location of center of gravity from leading edge
ao=-1.5;//geometric angle of attack for which lift is zero
a1=5;//angle of attack in degree
Cl1=0.52;//lift coefficient at 5 degree angle of attack
Awb=(.52-0)/(5-(-1.5))  //lift slope per degree
a2=1;//geometric angle of attack in degree
ab2=a2+1.5//absolute angle of attack at 1 degree
Cmcg=-0.01;//moment coefficient about center of gravity at 1 degree angle of attack
a3=7.88;//geometric angle of attack in degree
ab3=a3+1.5;//absolute angle of attack at 7.88 degree
Cmcg2=0.05;//moment coefficient about center of gravity at 7.88 degree angle of attack
//we have two equation in the form of Cmcg=Cmac+Clwb*(dh) and two unknown variables Cmac(moment coefficient about aerodynamic center )and dh(
```

```
   distance between aerodynamic center and center of
    gravity),so we use matrix method to solve them:
```

Scilab code AP 19 `Example 7.02data`

```
Clwb=0.45;//lift coefficient for wing body
Cmac=-0.016;//moment coefficient about the
   aerodynamic center
dh=0.05;//distance between aerodynamic center and
   center of gravity
```

Scilab code AP 20 `Example 6.09data`

```
//for the CP-1:
W=13127.5;//normal gross weight(N)
S=16.165;//wingarea(m^2)
a=4.2*%pi/180;//approx minimum glide angle(radian).
   from example 6.7
D1=0.905;//density at 3048 m(Kg/m^3)
D2=1.155;//density at 609.6 m(Kg/m^3)
Cl=0.634;//lift coefficient corresponding to minimum
    glide angle i.e maximum L/D(from example 6.1)
Wl=W/S//wing loading (W/S in N/m^2)
```

Scilab code AP 21 `Example 6.08data`

```
//for the CJ-1:
L_D=16.9;//maximum lift to drag ratio(L/D)
H=3048;//altitude(m) at which gliding starts.
```

Scilab code AP 22 `Example 6.07data`

```
//for the Cp-1:
L_D=13.6;//maximum lift to drag ratio(L/D)
H=3048;//altitude(m) at which gliding starts.
```

Scilab code AP 23 `Example 6.06data`

```
//for the CP−1(datas from example 6.1a):
b=10.912;//wingspan(meter)
S=16.165;//wingarea(mˆ2)
AR=bˆ2/S;//aspect ratio
D=1.225;//density at sea level(Kg/mˆ3)
W=13127.5;//normal gross weight(N)
f=65;//fuel capacity
P=230;//power provided by piston engine (unit−
   horsepower(hp))
Sf=2.0025;//specific fuel consumption(N/(hp.h))
Cdo=0.025;//parasite drag coefficient
e=0.8;//oswald efficiency factor
Pf=0.8;//propeller efficiency
V = linspace(30,80,500);//velocity over which we
   have to find thrust(30 to 400 m/s and over 500
   points)
Pa=P*Pf*746/1000//power available(KN−m/s)
```

Scilab code AP 24 `Example 6.05data`

```
//for the jet power executive aircraft(CJ−1):
Tf=2*16245;//thrust (N) provided by both turbofan
   engine
Do=1.225;//density(Kg/mˆ3) at sea level
D=0.6107;//density(Kg/mˆ3) at height 6705.6 m
b=16.25;//wingspan(meter)
S=29.54;//wingarea(mˆ2)
AR=bˆ2/S;//aspect ratio
W=88176.75;//normal gross weight(N)
Cdo=0.02;//parasite drag coefficient
e=0.81;//oswald efficiency factor
//in order to find max. velocity we need to find out
    the intersection of power required curve for
   example 6.3b and power available curve at height
   of 6705m:
```

Scilab code AP 25 `Example 6.4b-data`

```
//for the jet power executive aircraft(CJ-1):
Tf=2*16245;//thrust (N) provided by both turbofan
    engine
Do=1.225;//density(Kg/m^3) at sea level
D=0.6107;//density(Kg/m^3) at height 6705.6 m
b=16.25;//wingspan(meter)
S=29.54;//wingarea(m^2)
AR=b^2/S;//aspect ratio
W=88176.75;//normal gross weight(N)
Cdo=0.02;//parasite drag coefficient
e=0.81;//oswald efficiency factor
//in order to find max. velocity we need to find out
     the intersection of power required curve for
    example 6.3b and power available curve at height
    of 6705m:
```

Scilab code AP 26 Example 6.4a-data

```
//for the CP-1(datas from example 6.1a):
b=10.912;//wingspan(meter)
S=16.165;//wingarea(m^2)
AR=b^2/S;//aspect ratio
D=1.225;//density at sea level(Kg/m^3)
Cdo=0.025;//parasite drag coefficient
e=0.8;//oswald efficiency factor
W=13127.5;//normal gross weight(N)
P=230;//power provided by piston engine (unit-
    horsepower(hp))
Pf=0.8;//propeller efficiency
Pa=P*Pf*746/1000//maximum power(KN-m/s),1hp=746 N-m/
    s
```

Scilab code AP 27 Example 6.3b-data

```
//for the jet power executive aircraft(CJ-1):
b=16.25;//wingspan(meter)
S=29.54;//wingarea(m^2)
AR=b^2/S;//aspect ratio
```

```
D=0.6107;//density at 6705.6 meter
W=88176.75;//normal gross weight(N)
Cdo=0.02;//parasite drag coefficient
e=0.81;//oswald efficiency factor
V=linspace(20,300,500);//velocity over which we have to find Power(20 to 300 m/s and over 500 points)
```

Scilab code AP 28 Example 6.3a-data

```
//for the cessna skylane(CP−1):
b=10.912;//wingspan(meter)
S=16.165;//wingarea(m^2)
AR=b^2/S;//aspect ratio
D=1.225;//density at sea level
Cdo=0.025;//parasite drag coefficient
e=0.8;//oswald efficiency factor
Pf=0.8;//propeller efficiency
V = linspace(20,400,500);//velocity over which we have to find Power(20 to 400 m/s and over 500 points)
```

Scilab code AP 29 Example 6.20data

```
n1=9;//maximum load factor for piloted airplane
n2=25;//maximum load factor for UCAV
```

Scilab code AP 30 Example 6.02data

```
//consider the CJ−1 at sea level.
b=16.25;//wingspan(meter)
S=29.54;//wingarea(m^2)
AR=b^2/S;//aspect ratio
D=1.225;//density at sea level(Kg/m^3)
W=88176.75;//normal gross weight(N)
Tf=2*16245//thrust (N) provided by two turbofan engine
Cdo=0.02;//parasite drag coefficient
```

```
e=0.81;//oswald efficiency factor
V=linspace(40,300,500);//velocity over which we have
    to find thrust(40 to 300 m/s and over 500 points
   )
```

Scilab code AP 31 Example 6.19data

```
//for the cessna skylane(CP−1):
W=11494.35;//fuel empty weight(N)
W1=3916//total weight(N) including pilot seat etc
Wf=1633.15;//weight(N) of fuel
Wo=W+Wf-W1 //gross weight of UAV
b=10.912;//wingspan(meter)
S=16.16;//wingarea(m^2)
AR=b^2/S//aspect ratio
D=1.225;//density at sea level(Kg/m^3)
Cdo=0.025;//parasite drag coefficient
e=0.8;//oswald efficiency factor
Pa=0.8*230*746 //maximum power available(J/s) from
   example 6.4
//from example 6.12:
n=0.8;
c=7.45*10^-7;
```

Scilab code AP 32 Example 6.18data

```
//for the CJ−1:
W=54966.4;//empty weight(N)
S=29.54;//wingarea(m^2)
D=1.225;//density at sea level(Kg/m^3)
g=9.8;//Gravitational constant
Ur=0.4;//Rolling friction coefficient
Clmax=2.5;//maximum lift coefficient
Cd=0.02;//parasite drag coefficient
Cdo=Cd+.1*Cd;//increase in parasite drag coefficient
Vt=1.3*sqrt(2*W/(D*S*Clmax));//safe velocity(1.3*
   Vstall) during landing
Dr=D*(0.7*Vt)^2*S*Cdo/2;//drag(N)
```

Scilab code AP 33 Example 6.17data

```
//for the jet power executive aircraft(CJ-1):
W=88176.75;//normal gross weight(N)
b=16.25;//wingspan(meter)
S=29.54;//wingarea(m^2)
AR=b^2/S;//aspect ratio
e=0.81;//oswald efficiency factor
h=1.83;//Height(m)of wing above ground
D=1.225;//density at sea level(Kg/m^3)
g=9.8;//Gravitational constant
Ur=0.02;//Rolling friction coefficient
Cl=1.0;//maximum lift coefficient during ground roll
Cdo=0.02;//parasite drag coefficient
T=32485;//thrust(N)
phi=(16*h/b)^2/(1+(16*h/b)^2)//Ground effect factor
Vlo=1.2*sqrt(2*W/(D*S*Cl))//liftoff velocity(1.2*
    Vstall in m/s)
Dr=D*(0.7*Vlo)^2*S*(Cdo+phi*Cl^2/(%pi*e*AR))/2//drag
    (N)
L=D*(0.7*Vlo)^2*S*Cl/2//lift(N)
```

Scilab code AP 34 Example 6.16d-data

```
//for the jet power executive aircraft(CJ-1):
S=29.54;//wingarea(m^2)
D=1.225;//density at sea level(Kg/m^3)
W=88176.75;//normal gross weight(N)
Tf=16245;//thrust (N) provided by single turbofan
    engine
Cdo=0.02;//parasite drag coefficient
L_Dmax=16.9;//maximum L/D ,from example 6.13
```

Scilab code AP 35 6.16c-data

```
//for the jet power executive aircraft(CJ-1):
```

```
S=29.54;//wingarea(m^2)
D=1.225;//density at sea level(Kg/m^3)
W=88176.75;//normal gross weight(N)
Tf=16245;//thrust (N) provided by single turbofan
   engine
Cdo=0.02;//parasite drag coefficient
L_Dmax=16.9;//maximum L/D ,from example 6.13
```

Scilab code AP 36 `Example 6.16b-data`

```
//for the cessna skylane(CP-1):
b=10.912;//wingspan(meter)
S=16.165;//wingarea(m^2)
AR=b^2/S;//aspect ratio
D=1.225;//density at sea level(Kg/m^3)
W=13127.5;//normal gross weight(N)
f=65;//fuel capacity
P=230;//power provided by piston engine (unit-
   horsepower(hp))
Sf=2.0025;//specific fuel consumption(N/(hp.h))
Cdo=0.025;//parasite drag coefficient
e=0.8;//oswald efficiency factor
Pf=0.8;//propeller efficiency
L_Dmax=13.6;//maximum L/D from example 6.12
```

Scilab code AP 37 `Example 6.15data`

```
//for the jet power executive aircraft(CJ-1):
b=16.25;//wingspan(meter)
S=29.54;//wingarea(m^2)
AR=b^2/S;//aspect ratio
Cdo=0.02;//parasite drag coefficient
e=0.81;//oswald efficiency factor
```

Scilab code AP 38 `Example 6.14data`

```
//for the cessna skylane(CP-1):
```

```
b=10.912; //wingspan(meter)
S=16.165; //wingarea(m^2)
AR=b^2/S; //aspect ratio
Cdo=0.025; //parasite drag coefficient
e=0.8; //oswald efficiency factor
```

Scilab code AP 39 Example 6.13data

```
//for the jet power executive aircraft(CJ-1):
b=16.25; //wingspan(meter)
S=29.54; //wingarea(m^2)
AR=b^2/S; //aspect ratio
Wo=88176.75; //normal gross weight(N)
Wf=33211.9; //weight(N)of fuel
W1=Wo-Wf//empty weight(N)
c=0.6/3600//specific fuel consumption(1/s)
D=0.6107; //density at altitude 6705.6 m(Kg/m^3)
```

Scilab code AP 40 Example 6.12data

```
//for the cessna skylane(CP-1):
b=10.912; //wingspan(meter)
S=16.165; //wingarea(m^2)
AR=b^2/S; //aspect ratio
Wo=13127.5; //normal gross weight(N)
Wf=1632.5; //weight(N)of fuel
W1=Wo-Wf//empty weight(N)
n=0.8; //efficiency
c=2.0025/(3600*746)//specific fuel consumption(N/(hp
    .s))
D=1.225; //density at sea level(Kg/m^3)
```

Scilab code AP 41 Example 6.1b-data

```
//for the jet power executive aircraft(CJ-1):
b=16.25; //wingspan(meter)
S=29.54; //wingarea(m^2)
```

```
AR=b^2/S;//aspect ratio
D=1.225;//density at sea level(Kg/m^3)
W=88176.75;//normal gross weight(N)
f=1119;//fuel capacity
Tf=16245;//thrust (N) provided by single turbofan
   engine
Sf=0.102;//specific fuel consumption(N/(hp.h))
Cdo=0.02;//parasite drag coefficient
e=0.81;//oswald efficiency factor
V=linspace(40,300,500);//velocity over which we have
    to find thrust(40 to 300 m/s and over 500 points
   )
```

Scilab code AP 42 6.1a-data

```
//for the cessna skylane(CP-1):
b=10.912;//wingspan(meter)
S=16.165;//wingarea(m^2)
AR=b^2/S;//aspect ratio
D=1.225;//density at sea level(Kg/m^3)
W=13127.5;//normal gross weight(N)
f=65;//fuel capacity
P=230;//power provided by piston engine (unit-
   horsepower(hp))
Sf=2.0025;//specific fuel consumption(N/(hp.h))
Cdo=0.025;//parasite drag coefficient
e=0.8;//oswald efficiency factor
Pf=0.8;//propeller efficiency
V = linspace(30,400,500);//velocity over which we
   have to find thrust(30 to 400 m/s and over 500
   points)
```

Scilab code AP 43 Example 5.21data

```
Wt=712000;//total weight of plane including fuel (
   unit N)
D=1.225;//density at sea level(Kg/m^3)
S=153.29;//wing area in m^2
```

```
Clm=3;//maximum lift coefficient at subsonic speed
```

Scilab code AP 44 `Example 5.20data`

```
Wt=10258*9.8;//total weight of plane including fuel
   (unit N)
Wf=6071*9.8;//weight without fuel (unit N)
D=1.23;//density at sea level(Kg/m^3)
S=18.21;//wing area in m^2
Clm=1.15;//maximum lift coefficient at subsonic
   speed
```

Scilab code AP 45 `Example 5.19data`

```
a=2;//angle of attack for both wings
e=0.95;//span efficiency factor for both wings
a2=-1.5;//angle of attack at zero lift from standard
    data(also used in example 5.17)
//part a. for the airfoil of aspect ratio 4:
AR1=4;//aspect ratio.
ao=0.106;//infinite wing slope per degree (from
   example 5.17)
a1=ao/(1+57.3*ao/(%pi*e*AR1)) //lift slope for
   finite wing
Cl=a1*(a-a2) //lift coefficient at 2 degree
Cl1=a1*(a+0.5-a2) //lift coefficient at 2.5 degree
Dcl=Cl1-Cl //change in lift coefficient for wing 1(
   aspect ratio 4)

//part b. for airfoil of aspect ratio 10:
a11=0.088;//lift slope for finite wing per degree
   for aspect ratio 10(from example 5.17)
Cl2=a11*(a-a2)//lift coefficient at 2 degree
Cl22=a11*(a+0.5-a2) //lift coefficient at 2.5 degree
Dcl2=Cl22-Cl2 //change in lift coefficient for wing
   2(aspect ratio 10)
```

Scilab code AP 46 `Example 5.18data`

```
b=12.29;//wing span in meter
S=23.69;//wing area in m^2
AR=b^2/S //aspect ratio
D=1.225;//density at standard sea level,Kg/m^3
V=48.3*5/18 //velocity of flyer(m/s)
e=0.93;//span efficiency factor
W=3337.5;//total weight of the flyer in newton
L=W/2;//lift on one wing(out of two)in newton
q=(D*V^2/2) //dynamic pressure(N/m^2)
Cl=L/(q*S)//lift coefficient
Cdi=Cl^2/(%pi*e*AR) //induced drag coefficient
```

Scilab code AP 47 Example 5.17data

```
//consider a NACA-23012(finite wing)
Re=5*10^6;//reynold's number
e=0.95;//span efficiency factor
AR=10;//aspect ratio
a=4;//angle of attack in degree
//for a infinite wing of NACA-23012 airfoil:
Clo=1.2;//lift coefficient at 10 degree angle of
    attack
Cl1=0.14;//lift coefficient at 0 degree angle of
    attack
ao=(Clo-Cl1)/10 //infinite wing slope per degree
a1=ao/(1+57.3*ao/(3.14*e*AR)) //lift slope for
    finite wing
a2=-1.5;//angle of attack at zero lift from standard
     data
cd=0.006;//profile drag coefficient estimated from
    aerodynamic data
```

Scilab code AP 48 Example 5.16data

```
S=206;//wing area in m^2
AR=10;//aspect ratio
e=0.95;//span efficiency factor
W=7.5*10^5;//weight of the airplane in newton
```

```
Hd=3;//density altitude in Km
D=0.909;//density at density altitude of 3 Km(Kg/m
   ^3)
V=100;//flight velocity(m/s)
//lift is equivalent to weight,so
Cl=W/((D*V^2/2)*S)//lift coefficient
Cdi=Cl^2/(%pi*e*AR) //induced drag coefficient
Cd=0.006;//profile drag coefficient from estimated
   from aerodynamic data
q=(D*V^2/2)
```

Scilab code AP 49 `Example 5.15data`

```
b=7.7;//wingspan of the Northrop F-5(m)
e=0.8;//span efficiency factor
S=15.79;//wing area in m^2
AR=b^2/S//aspect ratio
Cl=0.6622;//lift coefficient(data taken from example
    5.14)
q=7651.224;//dynamic pressure in N/m^2(data taken
   from example 5.14)
```

Scilab code AP 50 `Example 5.14data`

```
S=15.79;//wing area in m^2
L=80000;//lift produced by wing
V=402.34*5/18;//velocity of airplane(m/s)
D=1.225;//density at sea level(Kg/m^3)
q=D*V^2/2 //dynamic pressure at sea level(N/m^2)
```

Scilab code AP 51 `Example 5.13data`

```
h=10;//flying altitude in Km
a=10*%pi/180;//angle of attack in radian
S=19.5;//wing planform area in m^2
M=2;//mach no
D=0.41351;//density at 10 Km(Kg/m^3)
```

```
T=223.26;//temperature(K) at 10 Km
V=(y*R*T1)^0.5*M //velocity at 10 Km(m/s)
q=D*V^2/2 //dynamic pressure at 10 Km
```

Scilab code AP 52 `Example 5.12data`

```
M=2;//mach no at which F-104 is flying
S=19.5;//wing planform area in m^2
//in steady flight lift equals to weight so:
L=7262*9.8 //lift (N)
R=287 ;//gas constant,J/Kg.K
y=1.4; //specific heat ratio for air
//part a(at sea level)
D=1.23;//density at sea level(Kg/m^3)
T=288;//sea level temperature(K)
V=(y*R*T)^0.5*M //velocity at sea level(m/s)
q=D*V^2/2 //dynamic pressure at sea level
//part b(at 10 Km)
D1=0.41351;//density at 10 Km(Kg/m^3)
T1=223.26;//temperature(K) at 10 Km
V1=(y*R*T1)^0.5*M //velocity at 10 Km(m/s)
q1=D1*V1^2/2 //dynamic pressure at 10 Km(N/m^2)
```

Scilab code AP 53 `Example 5.11data`

```
c=1.524;//chord length of airfoil(meter)
h=6096;//standard altitude(meter)
a=5*%pi/180;//angle of attack in radian
D=0.654;//density at standard altitude of 6096 meter
    ,Kg/m^3
T=248.6;//temperature at standard altitude of 6096
    meter in kelvin
R=287 ;//gas constant,J/Kg.K
y=1.4; //specific heat ratio for air
//for part a (mach no 3):
M=3;//Mach no.
q=D*((y*R*T)^0.5*M)^2/2 //dynamic pressure
Cl=4*a/(M^2-1)^0.5//lift coefficient
```

```
Cd=4*a^2/(M^2-1)^0.5//wave drag coefficient
//for part b(mach no 2):
M1=2;//Mach no.
q1=D*((y*R*T)^0.5*M1)^2/2 //dynamic pressure
Cl1=4*a/(M1^2-1)^0.5//lift coefficient
Cd1=4*a^2/(M1^2-1)^0.5//wave drag coefficient
```

Scilab code AP 54 Example 5.10data

```
//consider a NACA-0012 airfoil
Cpomin=-0.43;//minimum pressure coefficient on the surface of airfoil at low speed from figure of Cp vs x/c given in question.
M=linspace(0.4,0.9,6);//Mach number over which we have to calculate Cp critical.
y=1.4;//specific heat ratio for air.
```

Scilab code AP 55 Example 5.09data

```
//consider a NACA-4412 airfoil at an angle of attack of 4 degree.
a=4;//angle of attack in degree
//from standard table for NACA-4412 airfoil at 4 degree angle of attack we can get lift coefficient(at low speed):
Co=0.83;//lift coefficient(at low speed)
M=0.7;//Mach number
```

Scilab code AP 56 Example 5.08data

```
//consider an airfoil with chord length c and the running distance x measured along the chord.The leading edge is located at x/c=0 and the trailing edge x/c=1.
//pressure coefficient variation(Cpu for upper and Cpl for lower):
disp("Cpu=1-300*(x/c)^2  for 0<x/c<0.1");
```

```
disp("Cpu=-2.2277+2.2277*(x/c)  for 0.1<x/c<1.0");
disp("Cpl=1-0.95*(x/c)  for 0<x/c<1.0");
//putting the value of x/c as and integrating (Cpl-Cpu)dy from 0 to 1 we will get normal force coefficient Cn
Cn=integrate('1-0.95*y','y',0,1.0)-integrate('1-300*y^2 ','y',0,0.1)-integrate('-2.2277+2.2277*y','y',0.1,1.0)
```

Scilab code AP 57 Example 5.07data

```
V=80;//velocity of airplane(m/s)
//propertiess at point 1:
V1=110;//velocity(m/s)
Cp1=-1.5;//pressure coefficient
//propertiess at point 2:
Cp2=-0.8;//pressure coefficient
```

Scilab code AP 58 Example 5.06data

```
V=100;//velocity of airplane(m/s)
H=3000;//standard altitude at which airplane is flying(meter)
Cp=-2.2;//pressure coefficient at a point on fuselage
P=7.0121*10^4;//pressure at 3000 m,N/m^2
D=0.90926;//density at 3000 m,Kg/m^3
q=D*V^2/2 //dynamic pressure,N/m^2
```

Scilab code AP 59 Example 5.05data

```
Cpo=-1.18;//low speed value of pressure coefficient
M=0.6;//free stream mach number
```

Scilab code AP 60 Example 5.04data

```
//consider an airfoil mounted in a low speed subsonic wind tunnel.
```

```
V=30.5;//flow velocity in test section(m/s)
D=1.225;//standard sea level density,Kg/m^3
P=1.014*10^5;//standard sea level pressure,N/m^2
P1=1.01*10^5;//pressure at a point on airfoil,N/m^2
q=D*V^2/2 //dynamic pressure,N/m^2
```

Scilab code AP 61 `Example 5.03data`

```
H=2000;//standard altitude at which airplane is
    flying(meter)
P=7.95*10^4;//pressure corresponding to standard
    altitude,N/m^2
D=1.0066;//density corresponding to standard
    altitude,Kg/m^3
P1=7.58*10^4;//pressure at a point on wing,N/m^2
V=70;//airplane velocity in m/s
q=D*V^2/2 //dynamic pressure,N/m^2
```

Scilab code AP 62 `Example 5.02data`

```
//consider the same wing configuration as that of
    example 5.1.
L=700; //Lift per unit span
V=50; // velocity of flow in test section(m/s)
D=1.225;//standard sea level density,Kg/m^3
q=D*V^2/2  //dynamic pressure,N/m^2
S=1.3;//wing area,m^2
Cl=L/(q*S) //coefficient of lift
//from the value of Cl and wing configuration we can
     get angle of attack by using standard table:
a=1 //angle of attack in degree
//To cause zero lift Cl=0,so from standard table of
    Cl and Lift:
a1=-2.2 //angle of attack in degree
```

Scilab code AP 63 `Example 5.01data`

```
//A model wing is placed in a low speed subsonic
    wind tunnel.the wing has a NACA-2412 airfoil.
c=1.3;//chord length in meter
V=50; // velocity of flow in test section(m/s)
a=4;//angle of attack in degree
D=1.225;//standard sea level density,Kg/m^3
u=1.789*10^-5;//Viscosity in kg/(m)(s)
//from standard table for NACA-2412 airfoil with
    angle of attack 4 degree:
Cl=0.63;//Lift coefficient
Cm=-0.035;//moment coefficient about quarter chord
Re=D*V*c/u //reynold's no.
//from the value of Re and angle of attack and by
    using standard table we can get Cd:
Cd=0.007;//coefficient of drag
q=D*V^2/2  //dynamic pressure,N/m^2
```

Scilab code AP 64 `Example 4.28data`

```
//In this example flow over the wing is both
    turbulent and laminar.so to find drag we need to
    find drag on both laminar and turbulent layer and
     add them.
b=12.202;//wing span in meter
S=23.69;//wing area in m^2
c=S/b //wing width
Ret=6.5*10^5;//transition reynolds number or
    critical reynolds number
D=1.225;//density at standard sea level,Kg/m^3
u=1.79*10^-5;//Viscosity in at standard sea level in
     kg/(m)(s)
V=48.3*5/18 //velocity of flyer
q=D*V^2/2 //dynamic pressure
Re=D*V*c/u //reynolds no. at trailing edge
Xcr=(Ret*u)/(D*V) //distance from leading edge where
     transition occur
A=Xcr*b //area over which laminar flow occur in m^2
```

```
B=(c-Xcr)*b //area over which turbulent flow occur in m^2
```

Scilab code AP 65 `Example 4.27data`

```
//assume the boundary layer over the wing is turbulent
H=10668 ;//standard altitude at which F-104 is flying in meter
M=2;//Mach No.at which plane is flying
x=0.6096;//shear stress to be calculated at this distance downstream of leading edge
y=1.4; //specific heat ratio for air
R=287 ;//gas constant,J/Kg.K
//following are the datas at standard altitude of 10668 meter from standard tables
D=0.3807;//density,Kg/m^3
T=218.93;//temperature,Kelvin
V=(y*R*T)^0.5*M //velocity of the plane
u=1.35*10^-5;//viscosity from standard table of variation of u versus T      in kg/(m)(s)
Re=D*V*0.6096/u //reynolds no at 0.6096 meter:
Cfx=0.0592/Re^0.2 //incompressible skin fraction coefficient
//for mach 2 ratio of Cf/Cfx=0.2,so
Cf=0.74*Cfx //skin friction coefficient
q=D*V^2/2 //dynamic pressure
```

Scilab code AP 66 `Example 4.26data`

```
//repeatation of example 4.24,expect boundary layer is completely turbulent.
//datas taken from example 4.24:
V=120; //flow velocity,m/s
D=1.225;//free stream density,Kg/m^3
x=0.05 ;//length of plate in meter
w=1;//width of plate in meter
u=1.789*10^-5;//Viscosity in kg/(m)(s)
```

```
//reynolds no at 1 cm:
Re1=D*V*.01/u
//reynolds no at 5 cm:
Re2=D*V*.05/u
Cf1=0.0592/Re1^0.2 //Skin friction drag coefficient
    at 1 cm
Cf2=0.0592/Re2^0.2 //Skin friction drag coefficient
    at 5 cm
q=D*V^2/2  //dynamic pressure at outer edge of
    boundary ,N/m^2
```

Scilab code AP 67 `Example 4.25data`

```
//consider the flow same as in example 4.23,but
    assume boundaary layer is noe completely
    turbulent.
//datas are taken from example 4.23:
V=120; //flow velocity ,m/s
D=1.225;//free stream density ,Kg/m^3
x=0.05 ;//length of plate in meter
w=1;//width of plate in meter
u=1.789*10^-5;//Viscosity in kg/(m)(s)
Re=D*V*x/u  //Reynolds Number at trailing edge
Cf=0.074/Re^0.2 //Skin friction drag
q=D*V^2/2  //dynamic pressure at outer edge of
    boundary ,N/m^2
S=x*w;//area of plate ,m^2
```

Scilab code AP 68 `Example 4.24data`

```
//consider the flow of air over a small flat plate
    that is 5 cm long in flow direction and 1m wide.
    free stream conditions corresponds to standard
    sea level condition
V=120; //flow velocity ,m/s
D=1.225;//free stream density ,Kg/m^3
x=0.05 ;//length of plate in meter
w=1;//width of plate in meter
```

```
u=1.789*10^-5;//Viscosity in kg/(m)(s)
//reynolds no at 1 cm:
Re1=D*V*.01/u
//reynolds no at 5 cm:
Re2=D*V*.05/u
Cf1=0.664/Re1^0.5 //Skin friction drag coefficient
    at 1 cm
Cf2=0.664/Re2^0.5 //Skin friction drag coefficient
    at 5 cm
q=D*V^2/2  //dynamic pressure at outer edge of
    boundary ,N/m^2
```

Scilab code AP 69 Example 4.23data

```
//consider the flow of air over a small flat plate
    that is 5 cm long in flow direction and 1m wide.
    free stream conditions corresponds to standard
    sea level condition
V=120; //flow velocity ,m/s
D=1.225;//free stream density ,Kg/m^3
x=0.05 ;//length of plate in meter
w=1;//width of plate in meter
u=1.789*10^-5;//Viscosity in kg/(m)(s)
Re=D*V*x/u  //Reynolds Number at trailing edge
Cf=1.328/Re^0.5 //Skin friction drag coefficient
q=D*V^2/2  //dynamic pressure at outer edge of
    boundary ,N/m^2
S=x*w;//area of plate ,m^2
```

Scilab code AP 70 Example 4.22data

```
//consider the combustion chamber condition as
    reservoir
Po=20*1.01*10^5;//combustion chamber pressure in N/m
    ^2
To=3144;//combustion chamber temperature in Kelvin
R=378;//gas constant for mixture of kerosene and
    oxygen
```

```
y=1.26;//specific heat ratio
Pe=1*1.01*10^5//pressure at exit of rocket Nozzle in
    N/m^2
At=0.1;//throat area in m^2
Te=To*(Pe/Po)^((y-1)/y) //temperature at exit in
    degree kelvin
Me=sqrt(2*((To/Te)-1)/(y-1)) //mach no. at the exit
Ae=sqrt(y*R*Te) //speed of sound at exit ,m/s
Mt=1;//Mach no. at throat
Pt=Po/(1+(y-1)*Mt^2/2)^(y/(y-1)) //pressure at
    throatin N/m^2
Tt=To/(1+(y-1)*Mt^2/2) //temperature at throat in
    Kelvin
Dt=Pt/(R*Tt) //density of gas in throat ,Kg/m^3
Vt=sqrt(y*R*Tt) //speed of sount in throat which is
    equivalent to gas speed as mach no. at throat is
    1.
```

Scilab code AP 71 Example 4.21data

```
//in question pressure given is 1.013*10^5 but while
    solving it uses
//10*1.013*10^5,so we use the later.
Po=10*1.013*10^5 ;//reservoir pressure in Pascal
To=333.33; //reservoir temperature in Kelvin
Me=3;//mach no. at test section
y=1.4; //specific heat ratio for air
R=287 ;//gas constant ,J/Kg.K
Pe=Po*[1+(y-1)*Me^2/2]^((-y)/(y-1)) //exit pressure
Tstag=To //the stagnation point temperature remains
    same as that of total temperature(reservoir
    temperature) througout the compression
```

Scilab code AP 72 Example 4.20data

```
Me=2; //mach no in test section at standard sea
    level condition
```

```
//following are the standard sea level conditions
   desired at the exit of nozzle:
Pe=1.01*10^5;//static pressure,N/m^2
Te=288.16; //static temperature in Kelvin
y=1.4; //specific heat ratio for air
A=1+(y-1)*Me^2/2
```

Scilab code AP 73 Example 4.19data

```
//Assume the flow to be isentropic
P=1.013*10^5; //free-stream pressure,N/m^2
V=804.7*5/18; //free-stream velocity,m/s
D=1.23; //density,Kg/m^3
Pa=0.7167*10^5; //pressure at a point on airfoil
R=287 ;//gas constant,J/Kg.K
y=1.4; //specific heat ratio for air
T=P/(D*R) //free stream temperature
a=sqrt(y*R*T)//speed of sound at free stream
   temperature
M=V/a //free stream mach no.
To=T*(1+(y-1)*M^2/2) //free stream total temperature
Po=P*(1+(y-1)*M^2/2)^(y/(y-1)) //free stream total
   pressure
Poa=Po;//since the total presssure remains same
   inisentropic flow
Toa=To;//since the total temperature remains same
   inisentropic flow
```

Scilab code AP 74 Example 4.18data

```
V=4828.03*5/18//data for velocity is given in Kmph,
   to convert it to m/s multiply it by 5/18
P=0.0723*10^5;// ambient pressure,N/m^2
T=216.66;//ambient temperature in Kelvin
R=287 ;//gas constant,J/Kg.K
y=1.4; //specific heat ratio for air
M=V/(y*R*T)^0.5 //Mach number
//as M>1 so the flow is supersonic
```

Scilab code AP 75 Example 4.17data

```
Hp=10000; //pressure altitude in m
Po=4.24*10^4; //Total pressure measured by pitot
    tube ,N/m^2
P1=2.65*10^4; //pressure at pressure altitude 10000m
     from standard atmospheric table ,N/m^2
T=230; //ambient temperature in Kelvin
R=287 ;//gas constant for air ,J/Kg.K
y=1.4; //specific heat ratio for air
a=340.3; //speed of sound at sea level ,m/s
P=1.01*10^5 ;//stmospheric pressure at sea level
```

Scilab code AP 76 Example 4.16data

```
//pressure units are converted from bar to N/m^2
Hp=1524 ;//pressure altitude
P=0.8432*10^5 //From the standard atmosphere Table
    at 1524 meter ,N/m^2
Po=0.87*10^5 ;//total pressure in N/m^2
R=287 ;//gas constant for air ,J/Kg.K
T=280.56 ;//outside temperature ,Kelvin
D=P/(R*T) //density ,Kg/m^3
Ds=1.226 ;//standard sea level density ,Kg/m^3
```

Scilab code AP 77 Example 4.15data

```
//example 4.15 a/if P1-P2 ((1.019-1.01)*10^5) in
    example 4.14 is doubled what is the flow velocity
     in test section?b/if contraction ratio A1/A2
    (2/.5) is doubled then what is the flow velocity
    in test section?
V=40; //initial velocity in test section ,m/s
r=4; // A1/A2=2/0.5=4
R=8 ;//doubled value of A1/A2
Dp=(1.019-1.01)*10^5; //intial value of pressure
    difference
```

```
D=1.23; //density ,Kg/m^3
```

Scilab code AP 78 `Example 4.14data`

```
//Consider a low subsonic wind tunnel.
A1=2; //reservoir area ,m^2
A2=0.5; //test section area ,m^2
P2=1.01*10^5;//test section pressure ,N/m^2
V2=40;//flow velocity in test section
//from continuity equation
V1=V2*(A2/A1)//velocity  before test section
D=1.23; //density of flow equals standard sea level ,
    Kg/m^3
```

Scilab code AP 79 `Example 4.13data`

```
//In A low Speed subsonic wind tunnel,one side of a
    Mercury manometer is connected byto the reservior
     and the other side is connected to the test
    section.
r=1/15; //contraction ratio of nozzle A2/A1
P1=1.1*1.01*10^5 //reservior pressure ,N/m^2
T1=300 //reseroir temperature ,k
Dh=0.1 //height difference between the two coloumns
    of mercury in meter
D=1.36*10^4; //density of mercury ,Kg/m^3
g=9.8;
Dp=D*g*Dh //pressure difference between two coloums
    P2-P1
R=287; //gas constant for air ,J/Kg.k
D1=P1/(R*T1) //density of flowing material
```

Scilab code AP 80 `Example 4.12data`

```
//Nozzle flow was described in example 4.9,so we can
     take data from eg 4.9
V1=580 //velocity at throat ,m/s
```

```
Ve=1188 //velocity at exit ,m/s
T1=833 //Temperature at throat , in Kelvin
Te=300 //Temperature at exit , in kelvin
R=287;//gas constant for air ,J/Kg.K
y=1.4;// specific heat ratio for air
a=(y*R*T1)^0.5 //speed of sound at throat
Ae=(y*R*Te)^0.5 //speed of sound at exit
```

Scilab code AP 81 `Example 4.11data`

```
H=9144;//standard altitude of flying in metre
//from relation of altitude and Temperature:
T=228.81;//Temperature at Standard altitude of 9144
   m
V=885.14*5/18; //velocity of jet transport
R=287;//gas constant for air ,J/Kg.K
y=1.4;// specific heat ratio for air
a=(y*R*T)^0.5 //velocity of sound at that altitude
```

Scilab code AP 82 `Example 4.10data`

```
//Consider an airfoil in a flow of air ,where far
   ahead of airfoil conditions are given.
//the condition for pressure and velocity are not in
    SI unit so we need to convert it to SI unit.
P=1.013*1.01*10^5 //pressure far ahead of airfoil in
    N/m^2
V=804.7*5/18 //velocity far ahead of airfoil in m/s
D=1.23; //density in kg/m^3
R=287;//gas constant for air ,J/Kg.K
T=P/(D*R) //Temperature far ahead of airfoil in
   degree Kelvin
Pa=0.716*1.01*10^5 //pressure at a given point A on
   airfoil
Cp=1008; //for air specific heat at constant
   pressure ,J/Kg.K
y=1.4;// specific heat ratio for air
//Assuming isentropic flow:
```

```
Ta=T*(Pa/P)^((y-1)/y) //temperature at the given
    point A on airfoil
```

Scilab code AP 83 `Example 4.09data`

```
//deals with properties of air flow through
    supersonic wind tunnel
To=1000; //air temperature at the reservior of wind
    tunnel in degree Kelvin
Po=10*1.01*10^5; // air pressure at the reservior of
     wind tunnel in N/m^2
R=287; //gas constant for air
Do=Po/(R*To) //density at the reservior
Te=300; //static temperature at the exit in degree
    Kelvin
y=1.4;// specific heat ratio for air
T1=833; //temperature at the throat in degree Kelvin
Te=300; //temperature at the exit in degree Kelvin
D1=Do*(T1/To)^(1/(y-1)) //density at the throat
Mt=0.5;  //mass flow rate through nozzle ,Kg/s
Cp=1008; //specific heat at constant pressure for
    air ,J/Kg.K
De=Do*(Te/To)^(1/(y-1))
```

Scilab code AP 84 `Example 4.08data`

```
//The flow conditions are assumed to be isentropic
    in nature.
P1=20; //pressure of burned gas in combustion
    chamber in atm unit
T1=3500; //temperature of the burned gas in
    combustion chamber in degree kelvin
P2=0.5; //pressure of the gas at exit in atm
y=1.15; //specific heat ratio for the gas
```

Scilab code AP 85 `Example 4.07data`

```
//An airplane is flying at standard sea level
    condition.
//The flow conditions are assumed to be isentropic
    in nature.
T=250;//temperature at a point on wing in Kelvin
P1=1.01*10^5;//pressure at far upstream of wing
T1=288.16;//temperature at far upstream of wing
y=1.4;//ratio of specific heats for air
```

Scilab code AP 86 `Example 4.06data`

```
//Based on elementary Thermodynamics
//Part 1:SI unit
Cv=720;//specific heat at constant volume for air in
     standard condition in J/Kg.K
Cp=1008;//specific heat at constant pressure for air
     in standard condition in J/Kg.K
T=288;//standard temperature
e=Cv*T//internal energy per unit mass
h=Cp*T//enthalpy per unit mass
//Part 2:English Engineering unit
Cv1=4290;//specific heat at constant volume for air
    in Ft.Lb/slug*Rankine
Cp1=6006;///specific heat at constant volume for air
     in Ft.Lb/slug*Rankine
T1=519;//standard temperature in degree rankine
e1=Cv1*T1//internal energy per unit mass
h1=Cp1*T1//enthalpy per unit mass
```

Scilab code AP 87 `Example 4.05data`

```
R=0.1524;//radius(m) of semicircular cross section
V=30.48;//velocity(m/s) of free stream
D=1.23;//density(Kg/m^3) of free stream
```

Scilab code AP 88 `Example 4.04data`

```
A1=5;//convergent duct inlet area in m^2
V1=10;//inlet velocity in m/s
P1=1.2*10^5; //inlet pressure in N/m^2
T1=330;//inlet temperature in Kelvin
R=287;//gas constant for dry air
D=P1/(R*T1) //density of air in Kg/m^3
V2=30;//outlet velocity in m/s
P2=P1+D*(V1^2-V2^2)/2 //pressure at exit
```

Scilab code AP 89 `Example 4.03data`

```
//Application of Bernoulli's equation.an airfoil
    placed in a flow of air
P1=1.013;//pressure at far upstream  of airfoil in
    bar
V1=160*5/18  //velocity at far upstream  of airfoil
    in m/s
D=1.23;//density at far upstream of airfoil in Kg/m
    ^3
Pa=0.99;//pressure at a point Aon airfoil in bar
//velocity is low enough so we can assume
    incompressible flow,so
disp("P1+(D*V1^2/2)=Pa+(D*V2^2/2)","Bernoulli
    equation");
Va=[(2*(P1-Pa)/D)+(V1)^2]^0.5
```

Scilab code AP 90 `Example 4.02data`

```
A1=0.08;//convergent duct with inlet area in m^2
A2=0.771;//exit area
D1=1.23;//density of air at inlet
V1=210;//inlet velocity of air
V2=321;//outlet velocity of air
//as inlet velocity of 210 m/s is high speed flow
    density will vary
D2=(A1*V1*D1)/(A2*V2)  //density of air at the exit
    duct
```

Scilab code AP 91 Example 4.01data

```
//this example deals with basic of incompressible
    flow
A1=5;//convergent duct inlet area in m^2
V1=10;//inlet velocity in m/s
V2=30;//outlet velocity in m/s
A2=A1*V1/V2//area of duct exit
```

Scilab code AP 92 Example 3.04data

```
P=5.3*10^4;//ambient pressure in N/m^2
T=253;//ambient temperature in K
R=287;// gas constant for dry air in J/Kg.K
D=P/(R*T)
//as we do not have this value of pressure and
    density from standard table we will take two
    nearest value and interpolate to get the desired
    result.
H1=5100;
P1=5.331*10^4;//pressure corresponding to H1
H2=5200;
P2=5.2621*10^4;//pressure corresponding to H2
Hp=H1+[(H2-H1)*((P1-P)/(P1-P2))]//pressure altitude
    corresponding to p
H3=5000;
D3=0.73643;//density corresponding to H3 in Kg/m^3
H4=5100;
D4=0.72851;//density corresponding to H4 in Kg/m^3
Hd=H3+[(H4-H3)*((D3-D)/(D3-D4))] //density altitude
```

Scilab code AP 93 Example 3.03data

```

P1=9144//Pressure altitude in Km
P=0.3*10^5//corresponding pressure at pressure
    altitude in N/m^2
//density altitude:
```

```
D1=8686.8//density altitude in Km
D=0.485//corresponding density at sensity altitude in Kg/m^3
//Temperature at that altitude:
T=P/(D*R)//from equation of state
```

Scilab code AP 94 `Example 3.02data`

```
//datas are all taken from standard table of variation of temperature,pressure and density with height.
//Pressure at the flying altitude:
P=4.72*10^4;//in N/m^2
P1=6;//height corresponding to pressure P in Km
//Temperature at the flying altitude:
T=255.7;//in Kelvin
T1=5//height corresponding to temperature T in Km
D=P/(R*T)//density at that height
D1=6.24//height corresponding to density D in Km
```

Scilab code AP 95 `Example 3.01data`

```
//Temperature remains constant from 11 to 14 Km,so we are about to find pressure and density at a height of 11 Km.
T=216.66;//temp from 11 to 14 Km
T1=288.16;//sea level temperature
P1=1.01*10^5;//pressure at sea level in N/m^2
D1=1.23;//density at sea level in Kg/m^3
g=9.8;//earth's gravity in m/s^2
R=287;//gas constant for dry air in J/Kg.K
a=(216.66-288.16)/(1000*(11-0))  //Lapse rate from 0 to 11 Km
P=(P1)*(T/T1)^(-g/(a*R))//pressure at 11 Km
D=(D1)*(T/T1)^(-1*(g/(a*R)+1))//density at 11 Km
//as T is constant from 11 to 14 km we can use isothermal relation
h=14000;h1=11000;//height in meter
```

```
P2=P*(%e)^[-g*(h-h1)/(R*T)]//pressure at 14 Km
D2=D*P2/P  //density at 14 Km
```

Scilab code AP 96 `Example 2.6data`

```
//example 2.6:deals with the conversion of units; a
   piper cub airplane is flying at 60 mile per hour,
   convert its velocity in terms of ft/s and m/s
//1 mile=5280 ft,1 hour=3600 second,1 mile=1609.344

//Velocity in mile/hr:
V=60;
```

Scilab code AP 97 `Example 2.5data`

```
//Example 2.4 :deals with the conversion of units
   from one system to another
WingLoading=280.8;//unit Kgf/m^2
//1 ft=0.3048 m ,1lb=4.448N, 1 Kgf=9.8 N
```

Scilab code AP 98 `Example 2.4data`

```
//Example 2.4
P=1.04*10^4//unit N/m^2
R=287;//gas constant.of air(j/kg.k)
T=362;//unit K
density=P/(R*T)
```

Scilab code AP 99 `Example 2.3data`

```
//Air flowing at high speed in a wind tunnel has a
   pressure and temperature equal to 0.3 atm and
   -100 degree celcius,respectively.what is specific
    volme?
//1 atm=1.01*10^5 Pa or N/m^2
P=.3*1.01*10^5;//in N/m^2
//0 degree=273 Kelvin
```

```
T=-100+273;//in Kelvin
R=287;//gas constant for air.(j/kg.k)
density=P/(R*T)
v=1/density
```

Scilab code AP 100 Example 2.2data

```
//example2.2: The high pressure storage tank for a supersonic wind tunnel has a volume of 28.317 m^3.if air is stored at a pressure of 30 atm and a temperature of 299.44K,what is the mass of gas stored in the tank in Kg,and pound mass.
P=30*1.013*10^5;//1 atm=1.013*10^5 Pascal
R=287;//gas constant for air(J/Kg-K)
T=294.44 ;//temperature
density=P/(R*T);
V=28.317 ;//volume
M=density*V;//in kg
M1=2.20*M;//in pound
```

Scilab code AP 101 Example 2.1data

```
//example 2.1: The air pressure and density at a point on the wing of a Boeing 747 are 1.10 * 10^5 N/m^2 and 1.20kg/m^3,respectively.what is temperature at that point?
p=1.10*10^5;//given
density=1.20;//given
R=287;// gas constant.for air(j/kg.k)
T=p/((density)*(R))
```