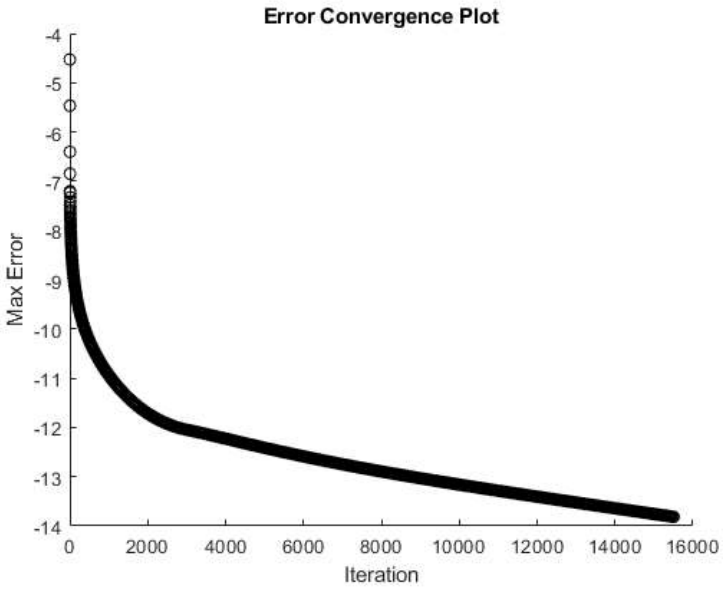
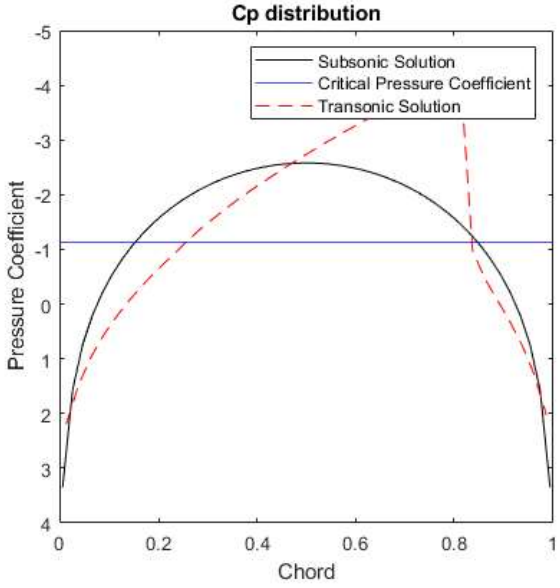
Lab 4 High Speed Aero

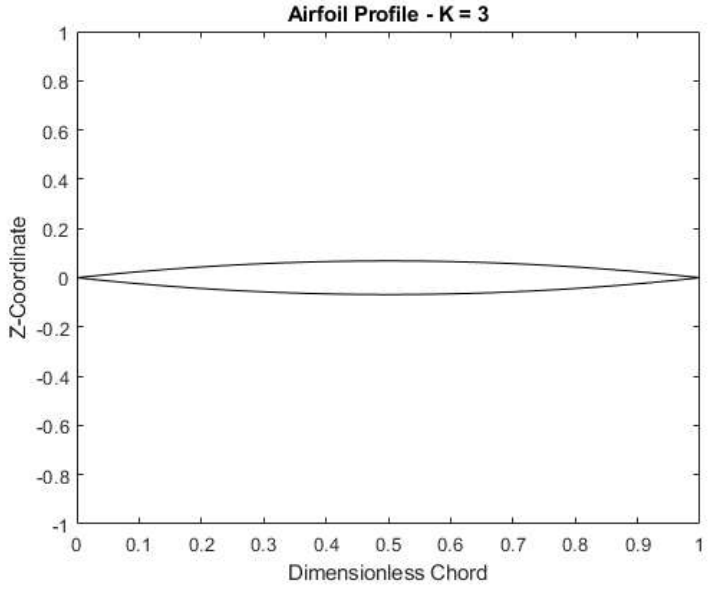
Blake Logan

```
clc;
clear all;
D1 = importdata('TSDEdata1_3.txt');
M = 0.85; K = 1.3;
x = linspace(-0.5,1.5,100);
z = linspace(-.5,1.5,100);
tau = (1/M^2)*nthroot(((1-M^2)/K),2/3);
zp = 2*tau.*(1-2.*x);
B = sqrt(1-M^2);
k = 0;
I = length(x);
J = length(z);
del = 0.02;
phi0 = zeros(I,J);
phi = zeros(I,J);
u = zeros(I);
e = [];
max_diff = 1;
emax = [];
max_diff_vec = [];
while max_diff > 1*10^-6

    emax = abs(phi - phi0);
    k = k+1;

    for i = 1:I
        for j =1:J
            if (x(i) == -0.5)
                phi(1,j) = phi(3,j);  %Left

            elseif (x(i) == 1.5)
                phi(I,j) = phi(I-2,j); %Right

            elseif z(j) == 1.5
                phi(i,J) = phi(i,J-2); %Top

            elseif (z(j) == -.5) && not((x(i) >= 0) && (x(i) <= 1))
                phi(i,1) = phi(i,3);

            elseif (z(j) == -.5) && ((x(i) >= 0) && (x(i) <= 1))
                phi(i,1) = phi(i,3) - 2.*del.*(2*tau.*(1-2.*x(i)));

            else
                phi(i,j) = ((B^2)*((phi0(i-1,j) + phi0(i+1,j))/(del^2)) + ((phi0(i,j+1) + phi0(i,j-1))/(del^2)))*((((2*B^2)/(del^2)) + (2/del^2))^(-1));

            end

        end
    end

    for i = 25:75
        u(i) = (phi(i+1,2) - phi(i-1,2))/(2*del);
    end

   max_diff = max(max(abs(phi - phi0)));  % Calculate the maximum difference
   max_diff_vec = [max_diff_vec, max_diff];

    phi0 = phi;
end

kplot = 1:1:k;

figure(1)
scatter(kplot,log(max_diff_vec),'k');
xlabel('Iteration');
ylabel('Max Error');
title('Error Convergence Plot');

ex2 = D1.data(:,1);
cp2 = D1.data(:,2);
uplot = u(26:75);
u1 = u(26:75);
ex = x(26:75);
explot = linspace(0,1,48);
```

```
cpplot = (-2.*uplot)./(tau^(2/3));
cp1 = (-2.*u1)./(tau^(2/3));
z = (2*tau)*(.25 - (ex - .5).^2);
cd = 2*(trapz(z,cp1));

z2 = (2*tau)*(.25 - (ex2 - .5).^2);

cd2 = 2*(trapz(z2,cp2));
cpcrit = ((2./(1.4.*M.^2)).*( ((2.*(1+(.4/2).*M.^2))./(2.4)).^(1.4/.4)-1))/(tau^(2/3));

figure(2)
plot(ex,cpplot,'k');
yline(cpcrit,'b');
hold on
plot(ex2,cp2,'r--');
hold off
axis ij
xlabel('Chord');
ylabel('Pressure Coefficient');
title('Cp distribution');
legend('Subsonic Solution','Critical Pressure Coefficient','Transonic Solution');
axis square

xx = linspace(0,1,100);
zx = (2*tau)*(.25 - (xx - .5).^2);

figure(3)

plot(xx,zx,'k');
hold on
plot(xx, -zx,'k');
hold off
xlim([0 1]);
ylim([-1 1]);
xlabel('Dimensionless Chord');
ylabel('Z-Coordinate');
title('Airfoil Profile - K = 3');
```


Error Convergence Plot
Max Error
Iteration
-4
-5
-6
-7
-8
-9
-10
-11
-12
-13
-14
0
2000
4000
6000
8000
10000
12000
14000
16000


Cp distribution
Subsonic Solution
Critical Pressure Coefficient
Transonic Solution
Pressure Coefficient
Chord
-5
-4
-3
-2
-1
0
1
2
3
4
0
0.2
0.4
0.6
0.8
1


Airfoil Profile - K = 3
Z-Coordinate
Dimensionless Chord
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Published with MATLAB® R2023a