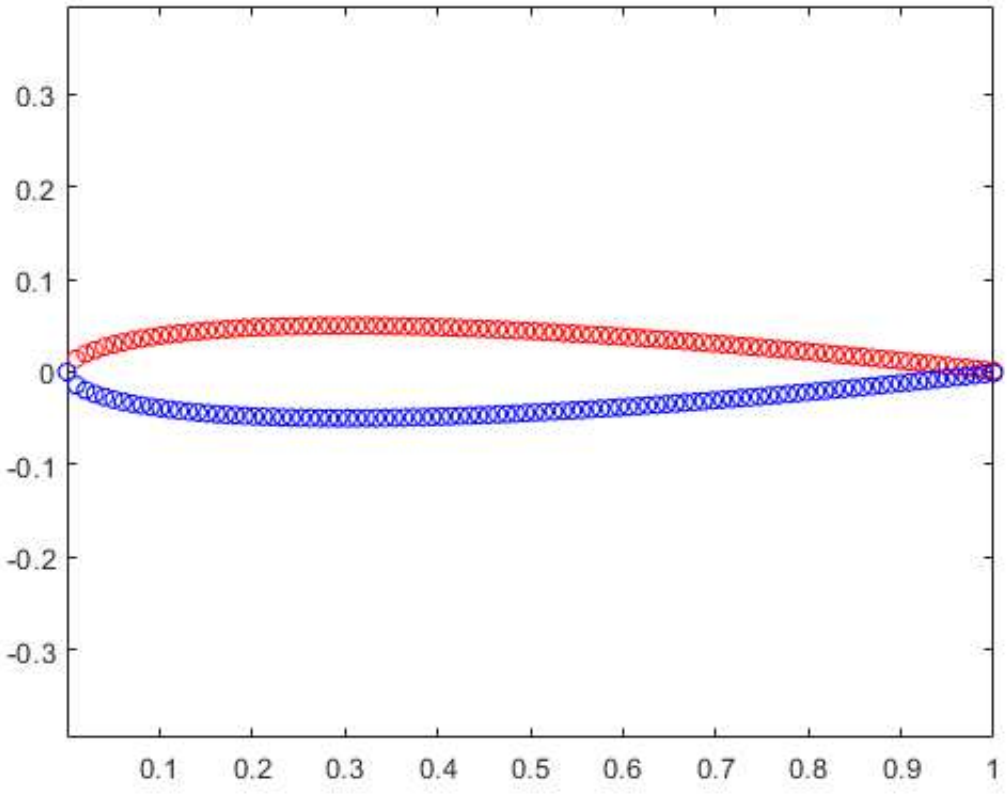
## Contents



```
%-------------------------
%     COMSOL PROJECT
%     AIRFOIL CODE
%     Jackson Busch
%    UID: 304 991 463
%      06/01/2020
%-------------------------
```

## NACA 0010

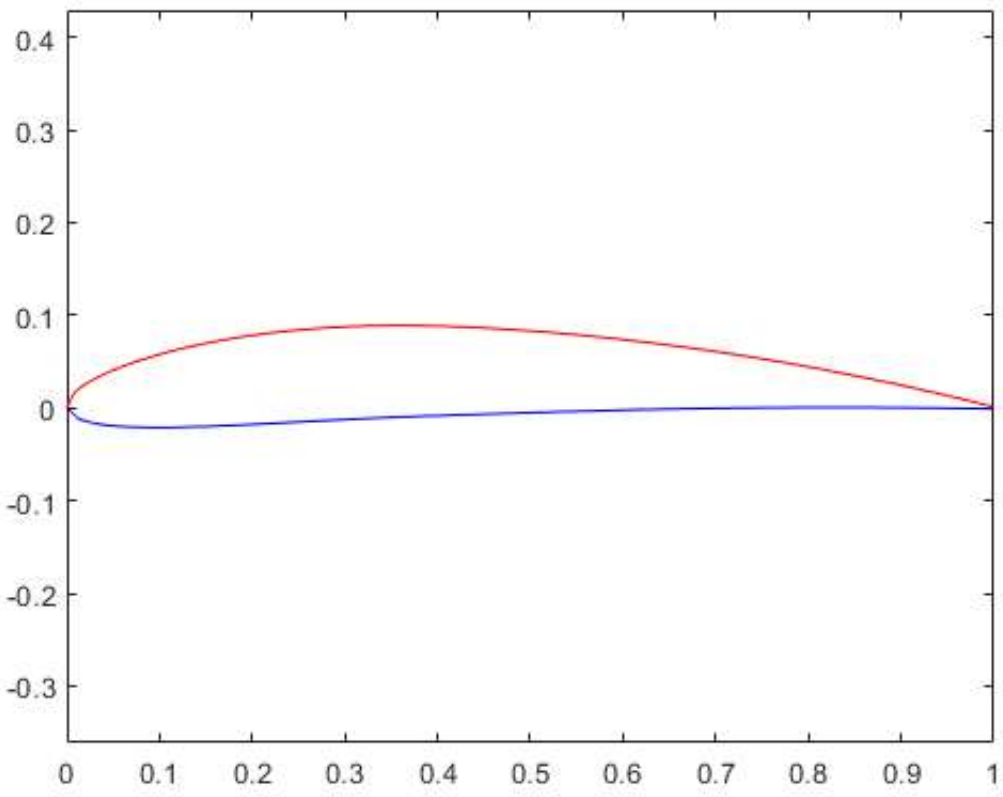
```
t = 0.1;
c = 1;
x = linspace(0,1,100);
ht = (t*c/0.2)*(.2969.*sqrt(x./c) - .126.*(x./c) - .3516.*(x./c).^2 + 0.2843*(x./c).^3 - .101
5*(x./c).^4);
yu = ht;
yl = -ht;

figure(1)
plot(x,yu,'or')
hold on
plot(x,yl,'ob')
hold off
axis equal

Y1 = [x;yu];
Y2 = [fliplr(x);fliplr(yl)];

Yact = [Y1,Y2].';
```




## NACA 4410

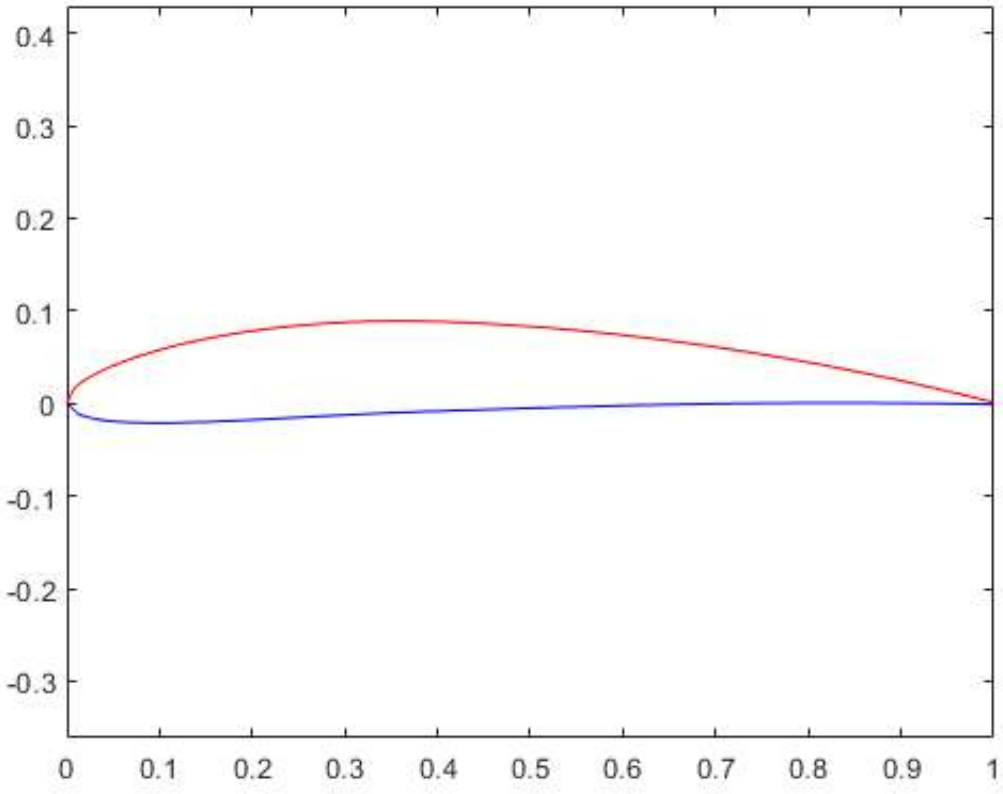
```
t = 0.1;
c = 1;
p = 0.4;
m = 0.04;
x = linspace(0,1,100);
ht = (t*c/0.2)*(.2969.*sqrt(x./c) - .126.*(x./c) - .3516.*(x./c).^2 + 0.2843*(x./c).^3 - .101
5*(x./c).^4);
yc1 = m*(x./p^2).*(2*p - x./c);
yc2 = m*((c-x)./(1-p)^2).*(1 + x./c - 2*p);
theta1 = atan((m*(2*p - x./c))./p^2 - (m.*x)./(c*p^2));
theta2 = atan((m*(c - x))./(c*(p - 1)^2) - (m*(x./c - 2*p + 1))./(p - 1)^2);
for i = 1:100
    if x(i) <= p*c
        yu(i) = yc1(i) + ht(i)*cos(theta1(i));
        yl(i) = yc1(i) - ht(i)*cos(theta1(i));
        xu(i) = x(i) - ht(i)*sin(theta1(i));
        xl(i) = x(i) + ht(i)*sin(theta1(i));
    else
        yu(i) = yc2(i) + ht(i)*cos(theta2(i));
        yl(i) = yc2(i) - ht(i)*cos(theta2(i));
        xu(i) = x(i) - ht(i)*sin(theta2(i));
        xl(i) = x(i) + ht(i)*sin(theta2(i));
    end
end
    YU = [xu;yu];
    YL = [fliplr(xl);fliplr(yl)];
    Ya = [YU,YL].';
```

```
    figure(2)
    plot(xu,yu,'r')
    hold on
    plot(xl,yl,'b')
    hold off
    axis equal
```




## Finding Theta

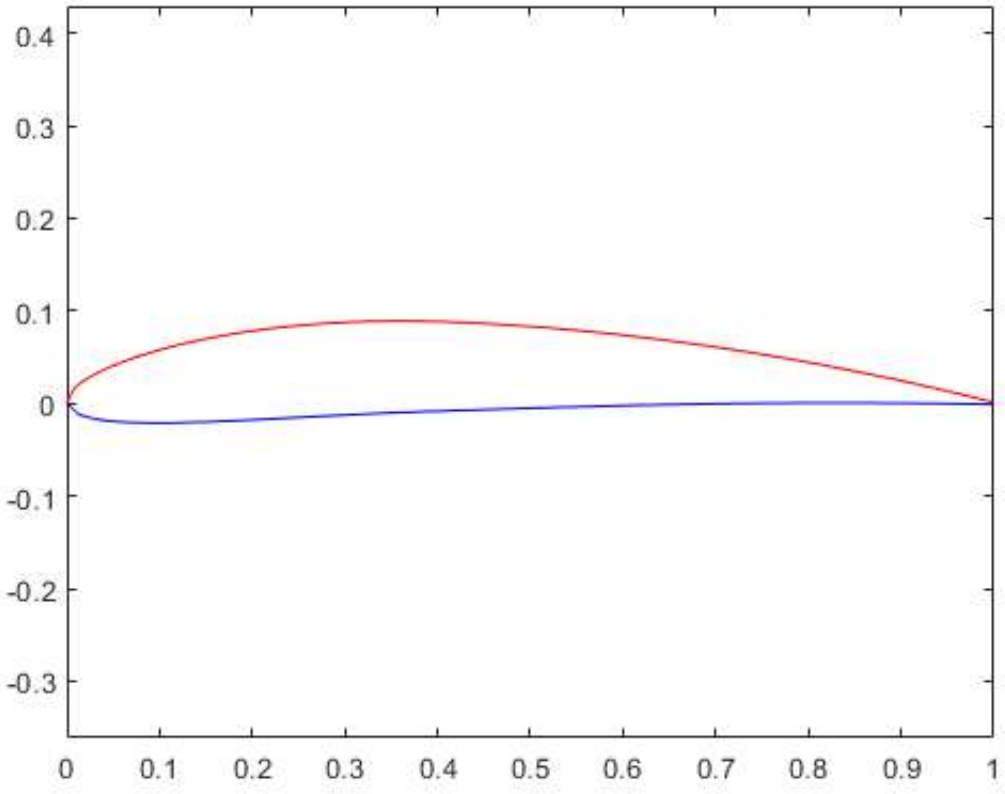
```
syms x p m c Q W
Q = m*(x/p^2)*(2*p - x/c);
W = m*((c-x)/(1-p)^2)*(1 + x/c - 2*p);

front = diff(Q);
back = diff(W);
```

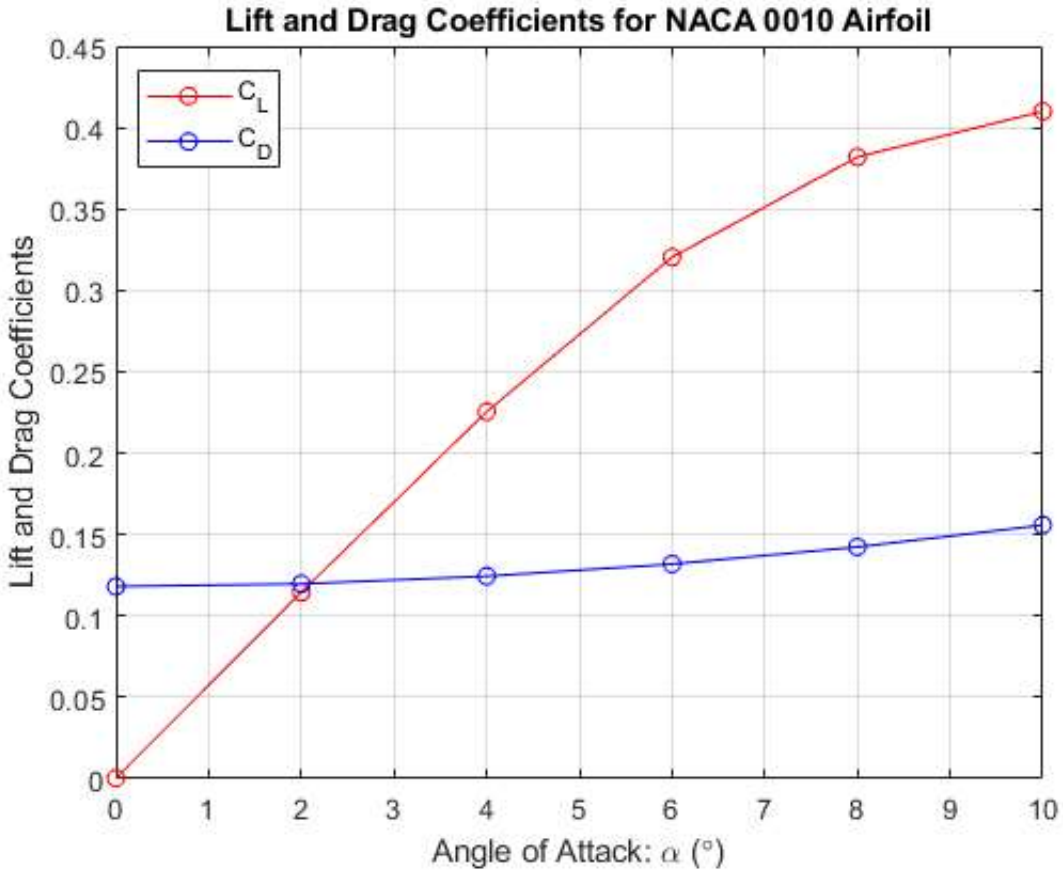


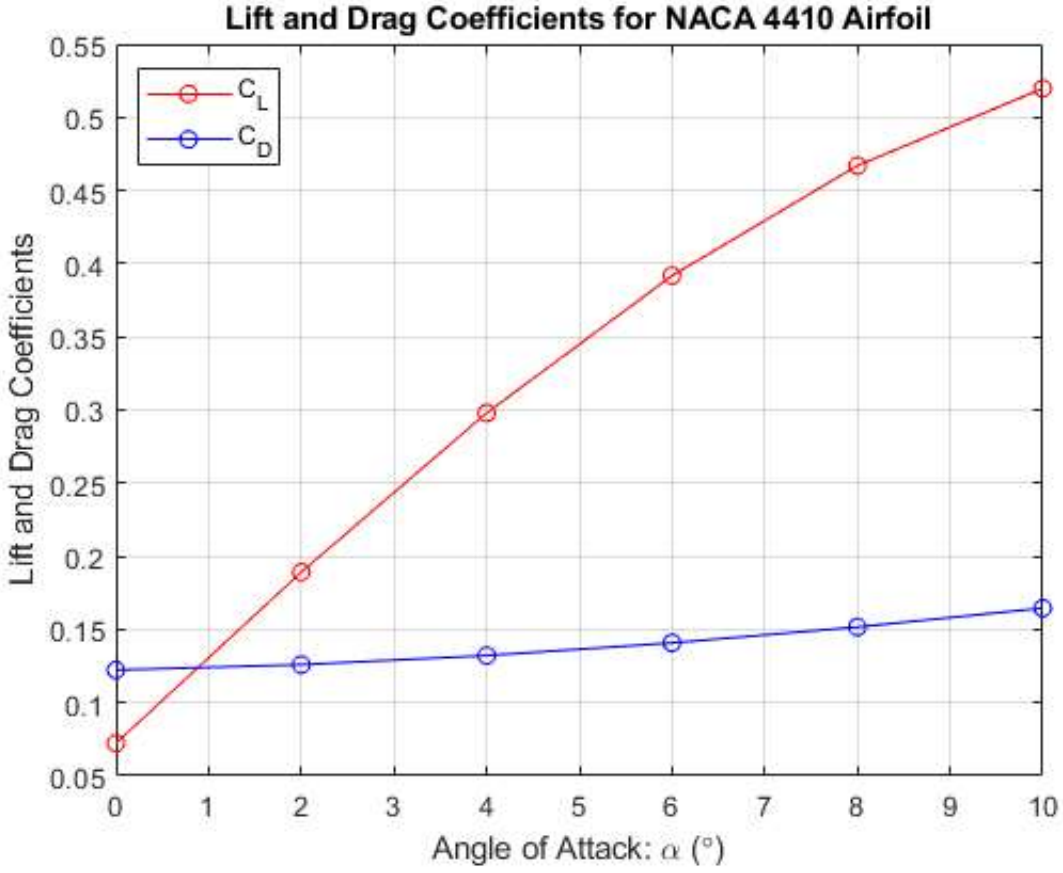

## Plotting Lift and Drag Coefficients

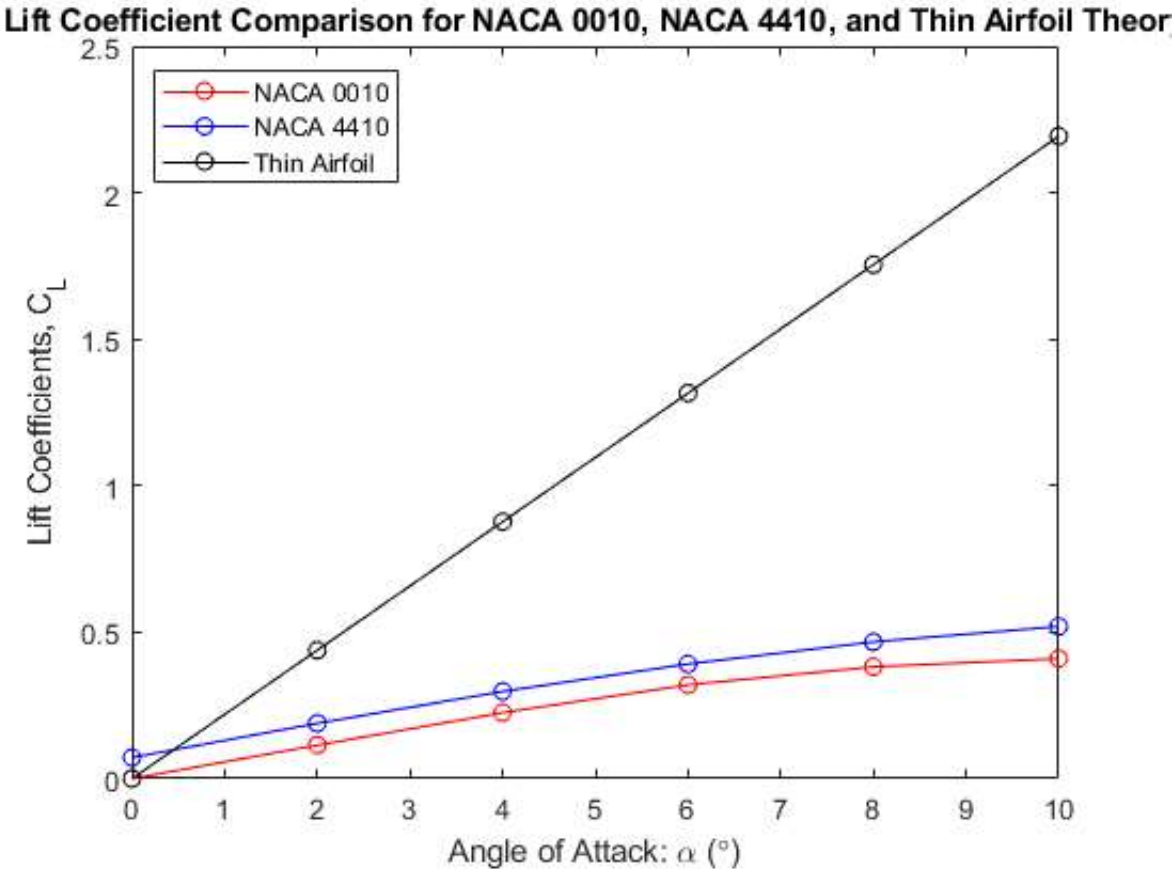
```
%Cylinder Drag Results
Uvals = [0.06,0.15,0.3,0.6,1.5,3];
Dc = [0.0013560,0.0048301,0.013315,0.038274,0.16363,0.50994];

%NACA 0010 Lift/Drag Results
alph = [0,2,4,6,8,10];
Lten = [0.0014401,0.51555,1.0145,1.4419,1.7188,1.8448];
Dten = [0.53140,0.53880,0.55981,0.59345,0.64061,0.70107];

%NACA 4410 Lift/Drag Results
Lfft = [0.32510,0.85138,1.3408,1.7630,2.1013,2.3383];
Dfft = [0.55054,0.56689,0.59488,0.63381,0.68259,0.74070];

%Solve for Lift and Drag Coefficients from Lift and Drag
rho = 1;
U = 3;
D = 0.1;
c = 1;
qinf = 0.5*rho*U^2;
qinfc = 0.5*rho*Uvals.^2;

%coeffs. for Cylinder D = 0.1m
CdCy = (Dc./(qinfc*D)).';

%coeffs. for NACA 0010
Clten = (Lten/(qinf*c)).';
Cdten = (Dten/(qinf*c)).';
```

```
%coeffs. for NACA 4410
Clfft = (Lfft/(qinf*c)).';
Cdfft = (Dfft/(qinf*c)).';

%lift coeff for thin airfoil
cthin = ((alph*2*pi)/180)*2*pi;

%Plots -------------------------------------
figure(3)
plot(alph,Clten,'o-r')
hold on
plot(alph,Cdten,'o-b')
hold on
grid
title('Lift and Drag Coefficients for NACA 0010 Airfoil')
xlabel('Angle of Attack: \alpha (\circ)')
ylabel('Lift and Drag Coefficients')
legend('C_L','C_D','location','NW')

figure(4)
plot(alph,Clfft,'o-r')
hold on
plot(alph,Cdfft,'o-b')
hold on
grid
title('Lift and Drag Coefficients for NACA 4410 Airfoil')
xlabel('Angle of Attack: \alpha (\circ)')
ylabel('Lift and Drag Coefficients')
legend('C_L','C_D','location','NW')

figure(5)
plot(alph,Clten,'o-r')
hold on
plot(alph,Clfft,'o-b')
hold on
plot(alph,cthin,'o-black')
hold off
title('Lift Coefficient Comparison for NACA 0010, NACA 4410, and Thin Airfoil Theory')
xlabel('Angle of Attack: \alpha (\circ)')
ylabel('Lift Coefficients, C_L')
legend('NACA 0010','NACA 4410','Thin Airfoil','location','NW')
```


0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


Lift and Drag Coefficients for NACA 0010 Airfoil
C_L
C_D
Lift and Drag Coefficients
Angle of Attack: α (°)
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
1
2
3
4
5
6
7
8
9
10


Lift and Drag Coefficients for NACA 4410 Airfoil
C_L
C_D
Lift and Drag Coefficients
Angle of Attack: α (°)
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1
2
3
4
5
6
7
8
9
10


Lift Coefficient Comparison for NACA 0010, NACA 4410, and Thin Airfoil Theor
NACA 0010
NACA 4410
Thin Airfoil
Lift Coefficients, C_L
Angle of Attack: α (°)
2.5
2
1.5
1
0.5
0
0
1
2
3
4
5
6
7
8
9
10

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