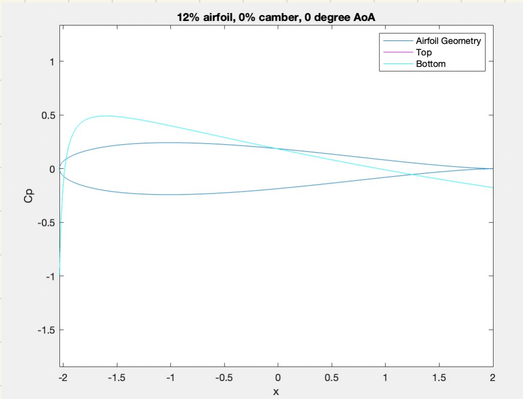
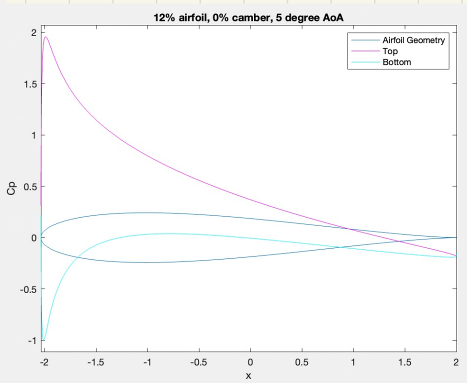
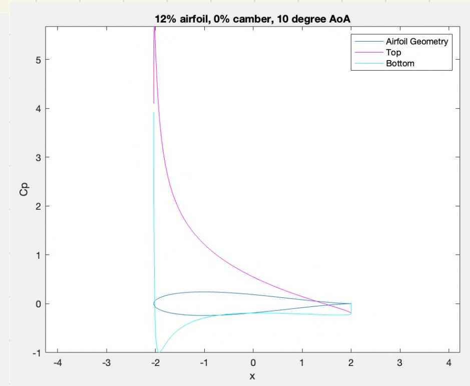
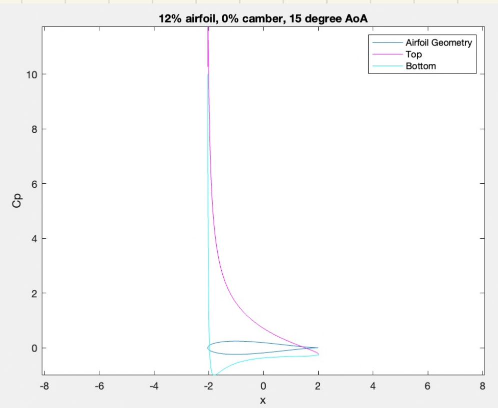
Lance Tan
Homework 4

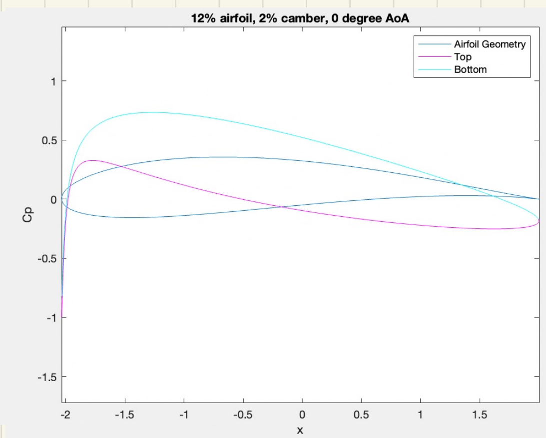
Pressure distribution at $\alpha = 0°, 5°, 10°, 15°$?

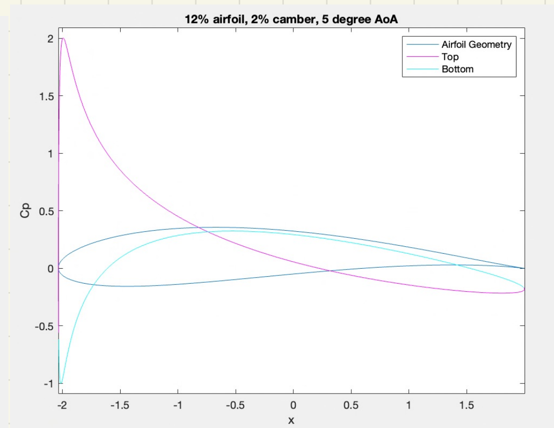


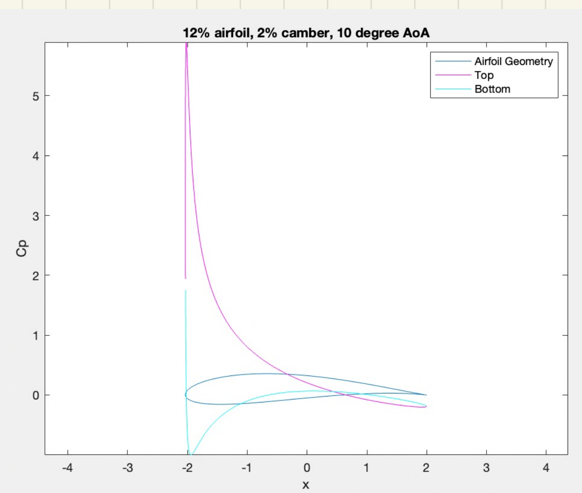


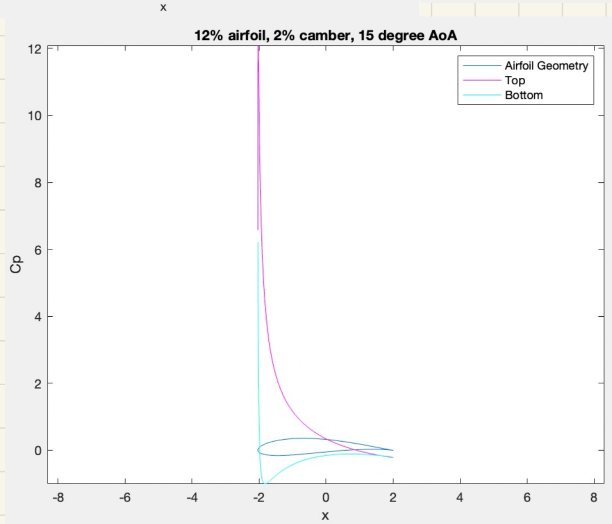






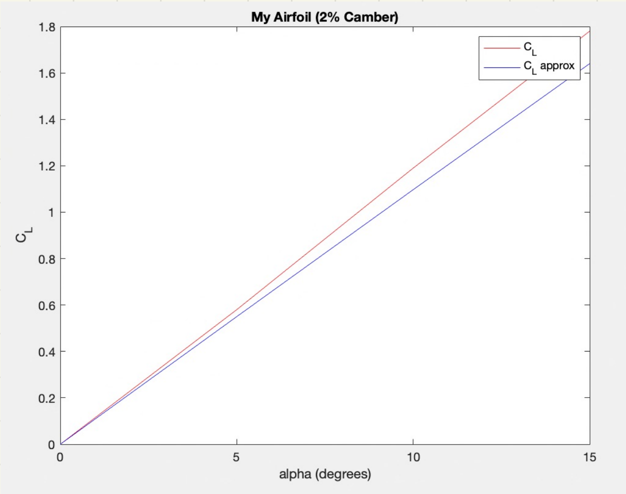


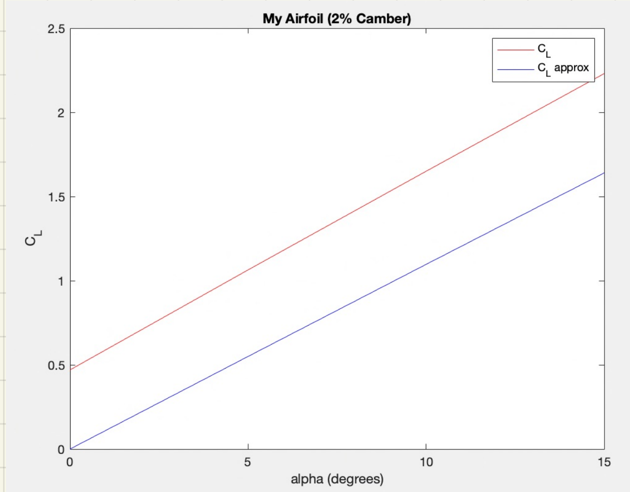




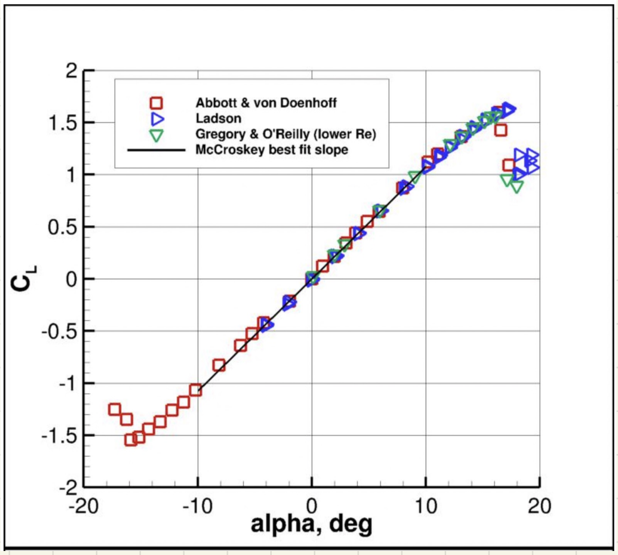
From the 0 degree angle of attack graphs, we can see a level of incidence between the top and bottom cp's. This incidence decreases more as the camber is added and as the angle of attack is increased. The relationships between the Cp's are not linear, which is something that is interestingly observed from the graphs.

Coefficient of Lift vs. angle of attack?





NACA 0012



Source: turbmodels.larc.nasa.gov/naca0012_val.html

Based on the graphs of my airfoil and the official NACA 0012 data, the same linear relations can be seen. The difference is when camber is added, since C_L now has a y-intercept term that is seen from the gap in the 2nd graph. This means that there may have been some constant added to the actual C_L relationship, causing this shift to occur.

```
clear all
close all
clc

v_inf = 1;
alpha = 15;
alpha = alpha*pi/180;
s_x = -0.102;
s_y = 0;
s = s_x + 1i*s_y;
r = sqrt((1-s_x)^2+s_y^2);

% Create points for airfoil
alpha_vec = linspace(0,2*pi,1000);

for idx = 1:length(alpha_vec)
    zeta(idx) = s + r*exp(1i*alpha_vec(idx));
end

% Apply Joukowsky Transform to obtain airfoil shape
z = zeta + 1./zeta;

% Compute velocity around airfoil
gamma = 4*pi*v_inf*r*sin(alpha + asin(s_y/r));
w_tilde = v_inf.*exp(-1i.*alpha) + 1i.*gamma./(2.*pi.*(zeta - s)) - v_inf.*(r.^2)*exp(1i.↙
*alpha)./((zeta - s).^2);
w = w_tilde./(1-(1./zeta.^2));
u = real(w);
v = -imag(w);
vel = sqrt(u.^2 + v.^2);

% Plot Airfoil
plot(real(z), -imag(z))
axis equal
l_c = max(real(z)) - min(real(z));
thickness = 100*(max(imag(z)) - min(imag(z)))/l_c;
hold on

z_t = z(1:500);
z_b = z(501:1000);
vel_t = vel(1:500);
vel_b = vel(501:1000);


% Plot pressure distribution
for j = 1:500
    cp_t(j) = 1 - (vel_t(j)./v_inf).^2;
    cp_b(j) = 1 - (vel_b(j)./v_inf).^2;
end
plot(real(z_t), -cp_t, 'm')
plot(real(z_b), -cp_b, 'c')
title('12% airfoil, 2% camber, 15 degree AoA')
xlabel('x')
ylabel('Cp')
legend('Airfoil Geometry', 'Top', 'Bottom')

% Plot coeff of lift vs. AoA
figure(2)
```

```
aoa = [0 5 10 15];
C_L_nocamb = [0 0.58 1.19 1.78];
C_L_camb = [0.47 1.064 1.65 2.23];
C_L_approx = [0 0.55 1.097 1.64];
plot(aoa, C_L_nocamb, 'r')
hold on
plot(aoa, C_L_approx, 'b')
legend('C_L', 'C_L approx')
xlabel('alpha (degrees)')
ylabel('C_L')
title('My Airfoil (2% Camber)')
```