1. For the FX 69-PR281 given below, use the Joukowski airfoil theory to estimate:

Very Nice and Neat!

10+/10

Measure:

chord = 129 mm
Max thickness = 37 mm
Max Chamber = 6 mm @ 50%

Non-dimensional:

$t/c = 37\,mm/129\,mm = 28.5\%$

$f/c = 6mm/129\,mm = 4.65\%$

Joukowski Parameters

$\epsilon = 77\% \cdot t/c = 0.77 \cdot .285 = .21945$

- $C_{l\,thickness} = 2\pi\left(\frac{1+\epsilon}{1+\epsilon^2}\right)\alpha$

$= 2\pi\left(\frac{1+.219}{1+.219^2}\right)\alpha$

$C_l = 2\pi\left(\underbrace{\alpha + \frac{2f}{c}}_{\text{needs to be } 0}\right)$

- $\alpha_{ZL} = -2f/c$

$\alpha_{ZL} = -2 \cdot .046$

$\alpha_{ZL} = -0.092\,rad = -5.78°$ ✓

$C_{l\alpha} = \frac{dC_l}{d\alpha} = 2\pi\left(\frac{1+.219}{1+.219^2}\right)$

$C_{l\alpha} = 2\pi \cdot 1.16$ ✓

- $C_{l0} = 2\pi\left(\cancel{\alpha}^{\,0} + \frac{2f}{c}\right)$

$= 2\pi \cdot \frac{2f}{c}$

$C_{l0} = C_{l\alpha} \cdot \frac{2f}{c} = 2\pi \cdot 1.16 \cdot 2 \cdot .0465 = 0.7 = C_{l0}$ ✓

- $C_{m\,c/4} = -\pi\frac{f}{c} = -\pi \cdot 0.0465$

$C_{m_{c/4}} = -0.144$ ✓

2. A spinning cylinder of radius 2 inches and span of 24 inches is generating 20 lb_f of lift in a 100 ft/s flow at SSL.
   - Determine the equivalent stream function (composed of a freestream, doublet and vortex). $\Psi(r,\theta) =$
   - Plot 5 or more relevant streamlines.

$$\Psi = V_\infty r \sin\theta \left(1 - R^2/r^2\right) + \frac{\Gamma}{2\pi} \ln\left(r/R\right) \qquad R = 2 \text{ inches} = .1667 \text{ ft}$$

$$L' = \rho V_\infty \Gamma$$

$$\Gamma = \frac{L'}{\rho V_\infty} = \frac{20 lb_f}{2 ft} \cdot \frac{1 \quad ft^3}{0.00237 \text{ slug}} \cdot \frac{s}{100 ft} = 42.194 \; ft^2/s$$

$$\Psi(r,\theta) = 100 \text{ ft/s} \cdot r \sin\theta \left(1 - \frac{.1667^2}{r^2}\right) + \frac{42.194}{2\pi} \ln\left(r/.1667\right)$$

$$\boxed{\Psi(r,\theta) = (100 \text{ ft/s}) \, r \sin\theta \left(1 - \frac{.02778}{r^2}\right) + 6.715 \ln\left(r/.1667\right)}$$

```
clear; clc;

xymax = 0.4;
x = linspace(-xymax,xymax,100);
y = linspace(-xymax,xymax,100);

[X,Y] = meshgrid(x,y);

R = sqrt(X.^2 + Y.^2);
sin = Y./R;
cos = X./R;

V = 100;
r = 2/12;
gam = 42.07;

psi = V.*R.*sin.*(1-r^2./R.^2) + gam.*log(R/r)/(2*pi);

figure
contour(X,Y,psi,[-50:5:50],'-r');
hold on
xlabel('X (ft)')
ylabel('Y (ft)')
title('\psi = BLUE')
axis equal
axis tight

```