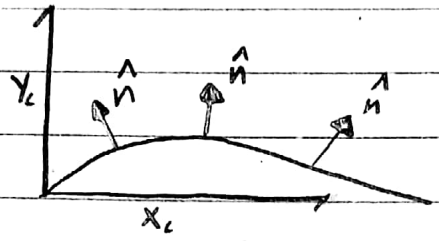
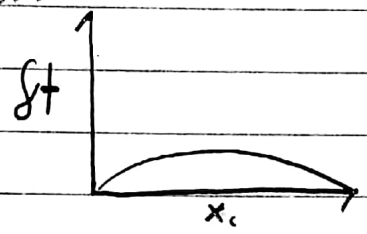
Defining An Air foil

Chamber Line:



Airfoil Thickness:



Direction of $\hat{n}$: $-\frac{dx}{dy}$ (recall from algebra)

Combine:

$$\begin{bmatrix} X_{u,l} \\ Y_{u,l} \end{bmatrix} = \begin{bmatrix} X_c \\ Y_c \end{bmatrix} \pm \frac{\delta t(x_c)}{|ds|} \begin{bmatrix} -dy/dx_c \\ 1 \end{bmatrix}$$

$m = dy/dx$ $\quad |ds| = \sqrt{1 + (dy/dx)^2}$ ← unit vector

$\begin{bmatrix} X_u \\ Y_u \end{bmatrix}$: + $\quad \begin{bmatrix} X_l \\ Y_l \end{bmatrix}$: −

Slope of airfoil:

$$\frac{d}{dx_c}\left[Y_u = Y_c + \frac{\delta t(x_c)}{|ds|} \right] \qquad \frac{d}{dx_c}\left[X_u = X_c - \frac{\delta t(x_c)}{|ds|} \cdot \frac{dy_c}{dx_c} \right]$$

$$\frac{dy_u}{dx_c} = \frac{dy_c}{dx_c} + \frac{d\delta t(x_c)}{dx_c} \cdot \frac{1}{|ds|} \qquad \frac{dx_u}{dx_c} = 1 - \frac{d\delta t(x_c)}{dx_c} \cdot \frac{dy_c}{dx_c} \cdot \frac{1}{|ds|} - \frac{\delta t(x_c)}{|ds|} \cdot \frac{d^2 y_c}{dx_c^2}$$

$$\frac{dy_u}{dx_u} = \frac{dy_u}{dx_c} \cdot \frac{dx_c}{dx_u}$$

$$\frac{dy_u}{dx_u} = \frac{\frac{dy_c}{dx_c} + \frac{d\,yt(x_c)}{dx_c} \cdot \frac{1}{|ds|}}{1 - \frac{d\,yt(x_c)}{dx_c} \cdot \frac{dy_c}{dx_c} \cdot \frac{1}{|ds|} - \frac{yt(x_c)}{|ds|} \cdot \frac{d^2 y_c}{dx_c^2}}$$

Chamber Eqn:

$$y_c = \begin{cases} \frac{m}{p^2}(2px - x_c^2) & \text{for } x_c \le p \\ \frac{m}{(1-p)^2}[(1-2p) + 2px_c - x_c^2] & \text{for } x_c \ge p \end{cases}$$

$$\frac{d}{dx_c}(y_c)$$

$$\frac{dy_c}{dx_c} = \begin{cases} \frac{m}{p^2}(2p - 2x_c) & \text{for } x_c \le p \\ \frac{m}{(1-p)^2}(2p - 2x_c) & \text{for } x_c \ge p \end{cases}$$

$$\frac{d^2 y_c}{dx_c^2} = \begin{cases} \frac{m}{p^2}(-2) & \text{for } x_c \le p \\ \frac{m}{(1-p)^2}(-2) & \text{for } x_c \ge p \end{cases}$$

Thickness Eqn:

$$yt(x) = \frac{tt}{0.2}\left(0.2969\sqrt{x} - 0.126x - 0.3516x^2 + 0.2843x^3 \ldots \right.$$
$$\left. \hookrightarrow -0.1015x^4\right)$$