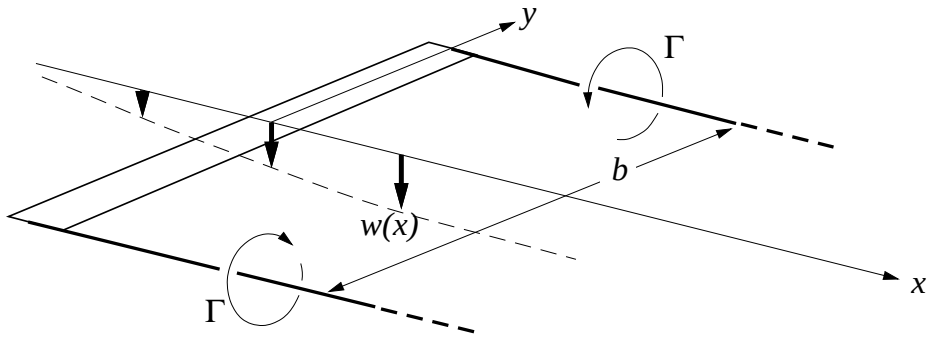
The vortices trailing from the wing produce a downwash velocity $w(x)$, which must be incorporated into 2D airfoil results to predict the 3D wing behavior.




a) For the configuration shown, with determine $w(x)$ using the Biot-Savart Law. Plot the results in nondimensional form $\bar{w}(\bar{x})$, where

$$\bar{w} \equiv \frac{b\,w}{\Gamma} \qquad\qquad \bar{x} \equiv \frac{x}{b}$$

b) Lifting-line theory makes the approximation that $w$ is effectively constant over the chord, and equal to the midchord value $w(0)$. In reality, there is some $w$ variation over the chord, the worst case being the TE-LE $w$ difference. Plot the downwash difference fraction, i.e.

$$\frac{\bar{w}(\bar{x}_{\rm TE}) - \bar{w}(\bar{x}_{\rm LE})}{\bar{w}(0)}$$

versus aspect ratio $AR \equiv b/c$.

c) Comment on the validity of lifting-line wing theory for short stubby fighter-plane wings.