1. a) \( \Gamma = 2\pi (\alpha(t) - \alpha_{\infty}) \) instantaneous lift corresponds to instantaneous \( \alpha \), as given

\[ \Gamma = \frac{1}{2} V_\infty c_\ell \Gamma \]

\( \therefore \) \( \Gamma(t) = \frac{1}{2} V_\infty c_\ell 2\pi (\omega t - \alpha_{\infty}) \) \((\alpha_{\infty} = 0 \text{ if airfoil is symmetric})\)

b) Let \( L \) be the length of wake inside larger circuit at time \( t \).

At time \( t \):

\( \Gamma_1 = \Gamma(t) + \gamma L \)

At time \( t+\Delta t \):

(circuit moves with flow)

\( \Gamma_2 = \Gamma(t+\Delta t) + \gamma(L+\Delta L) \)

\( \Delta L = V_\infty \Delta t \) (moves with flow)

Since circuit is defined to move with flow, Kelvin's Theorem applies:

\[ \Gamma_1 = \Gamma_2 \]

\[ \frac{1}{2} V_\infty c_\ell 2\pi (\omega t - \alpha_{\infty}) + \gamma L = \frac{1}{2} V_\infty c_\ell 2\pi (\omega(t+\Delta t) - \alpha_{\infty}) + \gamma (L+\Delta L) \]

after cancelling left & right terms:

\[ 0 = \frac{1}{2} V_\infty c_\ell 2\pi \omega \Delta t + \gamma V_\infty \Delta t \]

\[ \gamma = -\pi c_\ell \omega \]

C) Vortex sheet causes downwash at airfoil.

Lift vector will tilt aft, giving \( D' > 0 \)

\[ D' > 0 \]

\[ \gamma < 0 \]