AE 707: Tutorial on Finite Wing Aerodynamics

Elliptic and General Load Distributions

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1. [Anderson, 2011, P5.4 (Converted from FPS to SI units, and simplified.)] A light, single-engine general aviation aircraft has an untwisted wing with elliptic planform of area 16 m^2 and span 10 m. Its maximum gross weight is 11 kN. The wing uses an NACA 65-415 airfoil, which has a lift slope of 0.1033 $degree^{-1}$ and $\alpha_{L=0} = -3°$. If the airplane is cruising at 55 m/s at standard sea level (density = 1.225 kg/m^3) at its maximum gross weight and is in straight-and-level flight, calculate the geometric angle of attack of the wing.

2. [Simplified version of Houghton's Example 5.6] Consider a straight (i.e., unswept), tapered, untwisted, symmetrical wing consisting of a symmetrical airfoil cross-section in incompressible flow. The measured data at the wing root and wing tip are as follows:

Parameter	**Wing root data**	**Wing tip data**
Chord [m]	3.0	1.5
Total span of wing b [m]: 13.5 m		

   Assume linear variation of the above measured parameters between the wing root and wing tip, and typical linear variation of sectional lift at individual airfoil cross-sections with constant lift-slope of $a_0 = 6$ per radian. Use lifting-line theory to find the lift-curve slope for the finite wing, and hence the value of τ. For this, use three non-trivial terms in the expansion of the bound vortex circulation Γ, and evaluate the lifting line equation at 3 points on the wing corresponding to $\theta = \pi/6,\ \pi/3$, and $\pi/2$ for your analysis incorporating above measured data.