Camber Effects

Unsteady Lift

In the following simulations, the effect of camber on the produced lift spectrum is studied. As was with the previous cases, a vortex of strength Γ = -0.02 was started upstream at an initial position of (-4.5, 0.06). While there are no analytical functions that allow us to compare the effects of camber on the lift spectrum, previous work by Martinez [1] provide some sort of comparison for trend prediction.

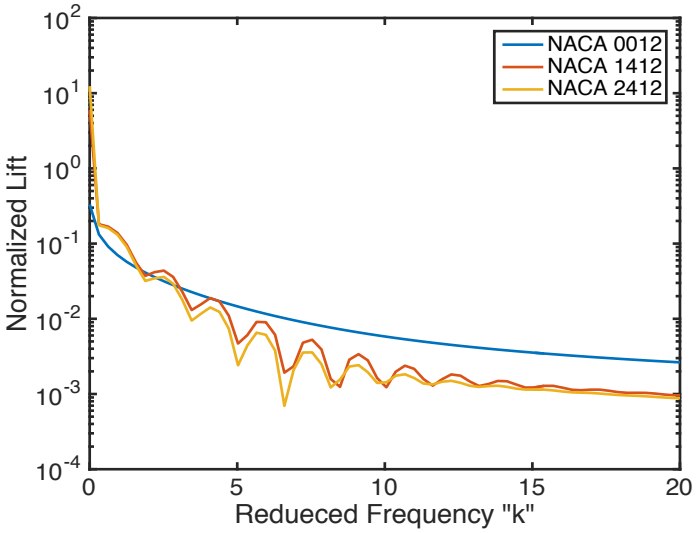


Figure 1: Effect of Camber on Lift Spectrum

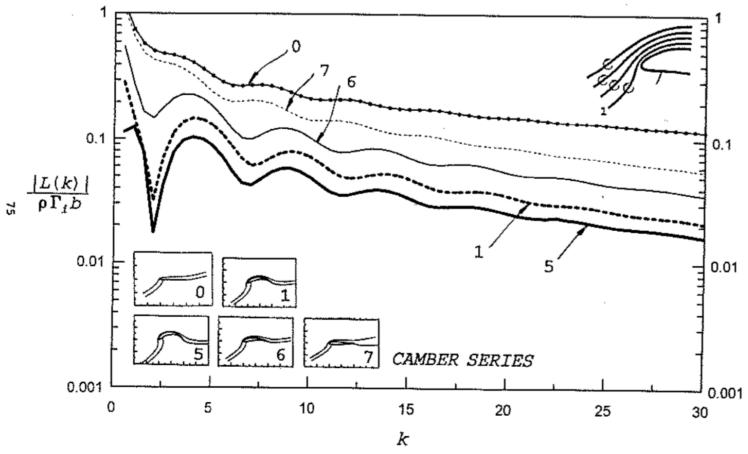


Figure 2: Results of Martinez [1] showing effects of camber

Comparing the two figures, the predicted response values for the current method are smaller than those predicted in [1]. The pattern though seems to be the same with increasing camber of the airfoils resulting in a progressively smaller response.

[1] Martinez R. Rudzinsky J. and Atassi H. M. Analytic Evaluation of Shape Effects on Blade Vortex Interaction Dec. 1997.

As was done with the flat plate and thickness comparisons, the results of the BEM calculation were compared to other previously validated codes. The figures below show those comparisons for several difference NACA airfoil configurations.

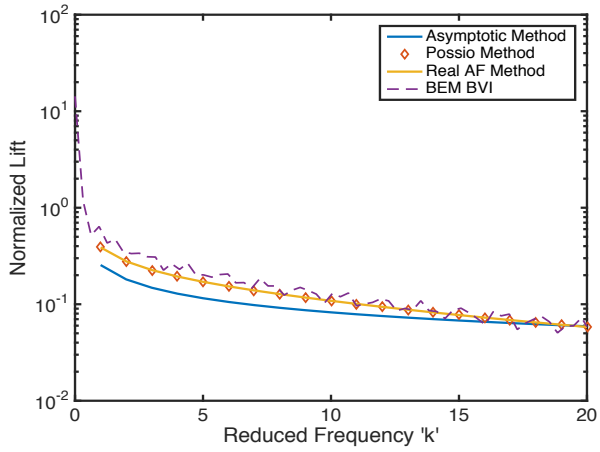


Figure 3: NACA 1101

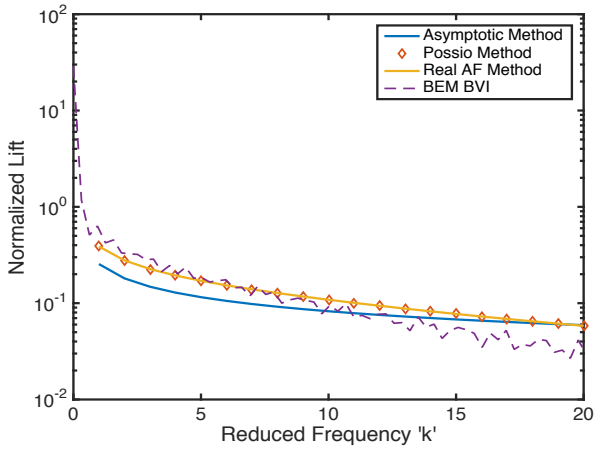


Figure 4: NACA 2101

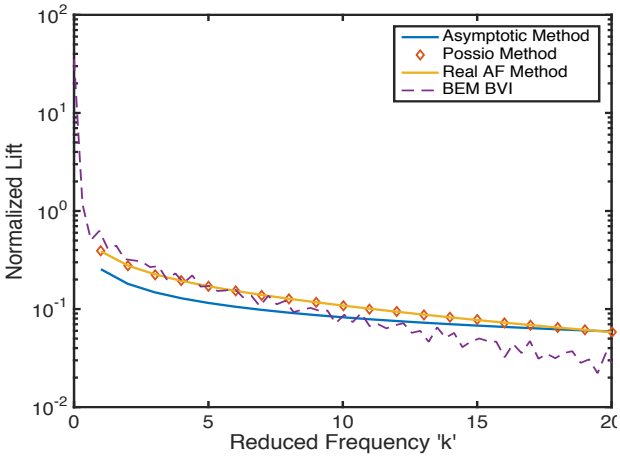


Figure 5: NACA 2401

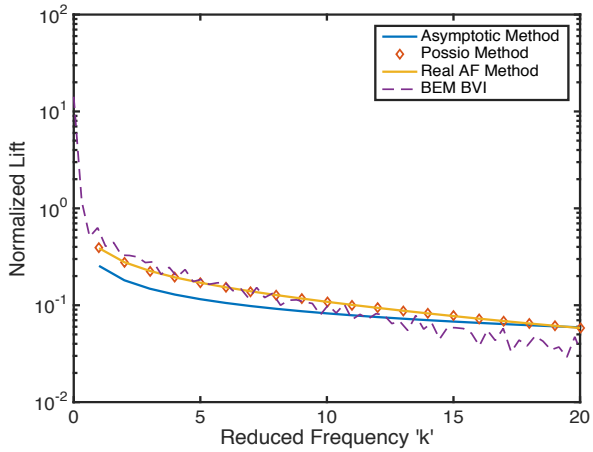


Figure 6: NACA 1103

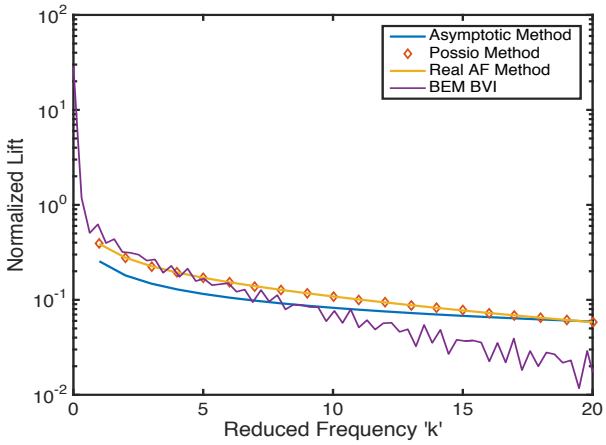


Figure 7: NACA 2103

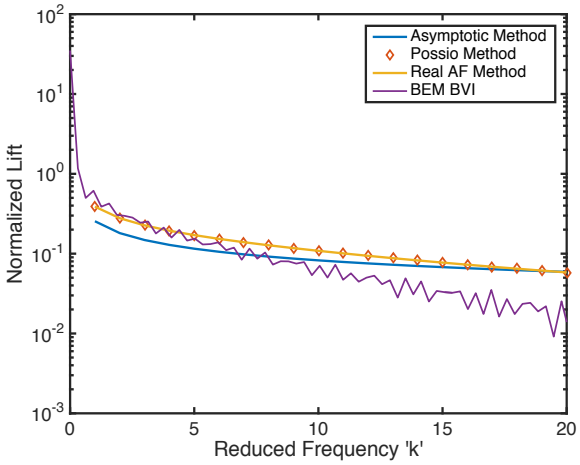


Figure 8: NACA 2403

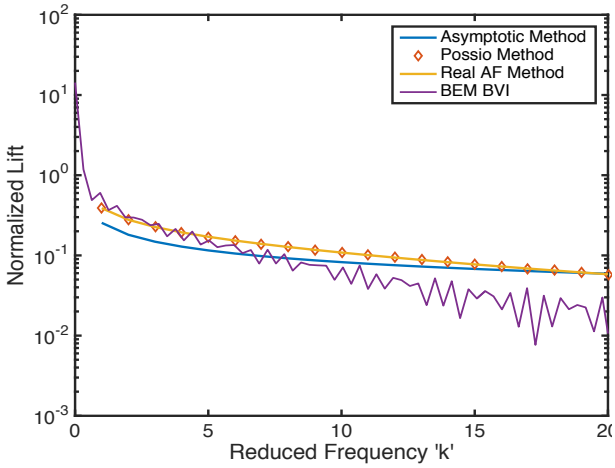


Figure 9: NACA 1106

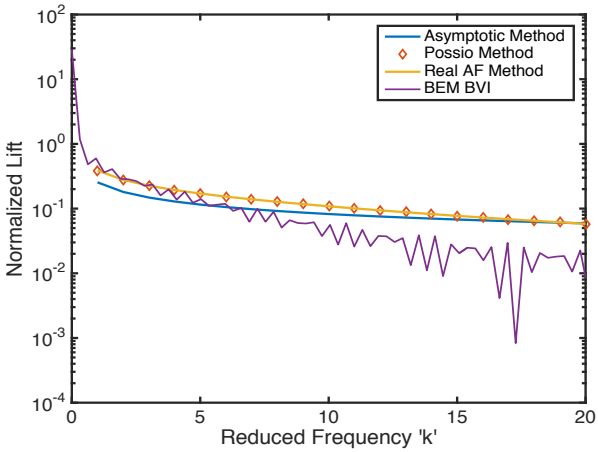
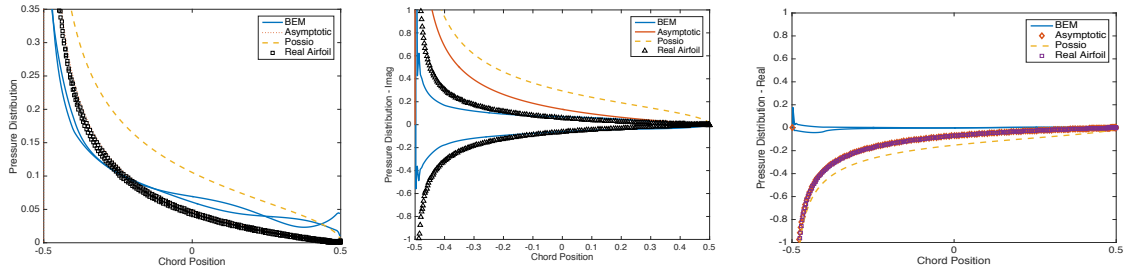


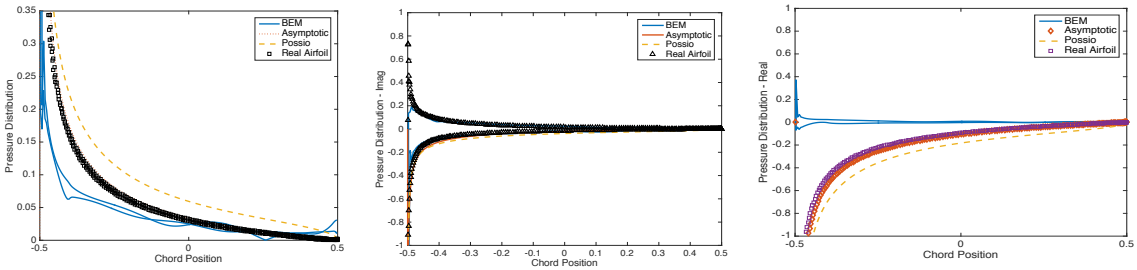
Figure 10: NACA 2106

Unsteady Pressure



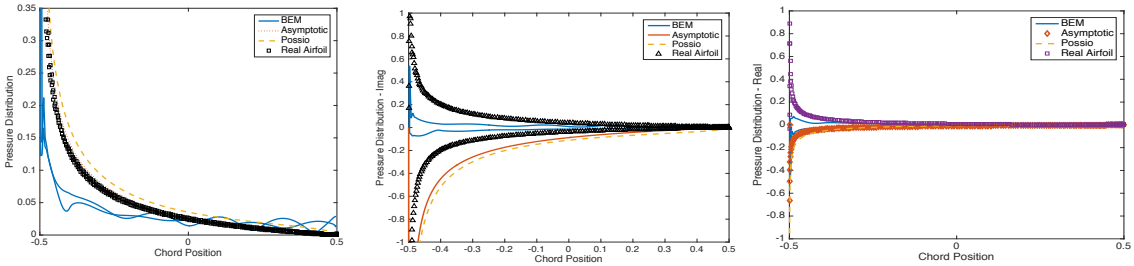
(a) Magnitude (b) Imaginary (c) Real

Figure 11: Pressure Distribution of NACA 1101 airfoil for a reduced frequency of k=5



(a) Magnitude (b) Imaginary (c) Real

Figure 12: Pressure Distribution of NACA 1101 airfoil for a reduced frequency of k=10



(a) Magnitude (b) Imaginary (c) Real

Figure 13: Pressure Distribution of NACA 1101 airfoil for a reduced frequency of k=15