Solution to Problem 136A:

[a] The following are the shapes of four Joukowski foils with the horizontal, ξ, coordinates scaled so the chord is 1.0. The last demonstrates the camber on a foil with $c/a = 1.0$ and $\beta = 4°$.

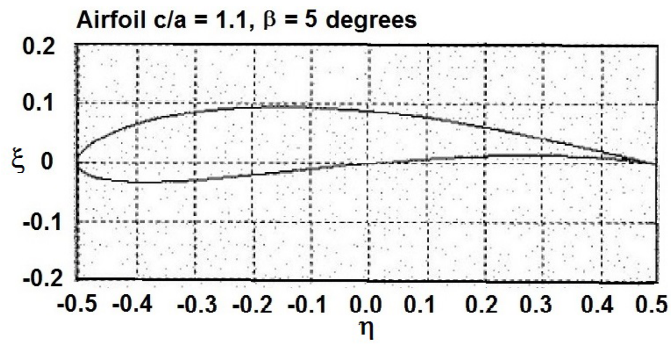

Figure 1: Joukowski airfoil shape for $c/a = 1.1$ and $\beta = 5°$.

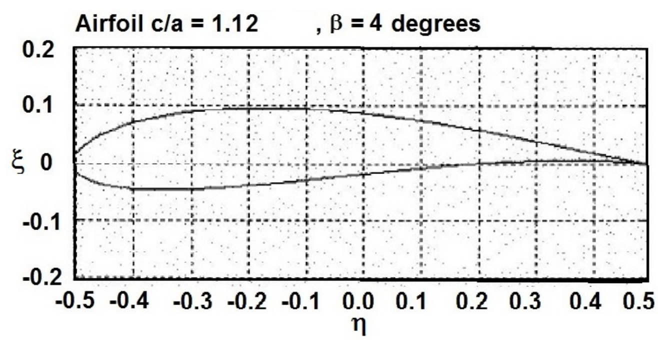

Figure 2: Joukowski airfoil shape for $c/a = 1.12$ and $\beta = 4°$.

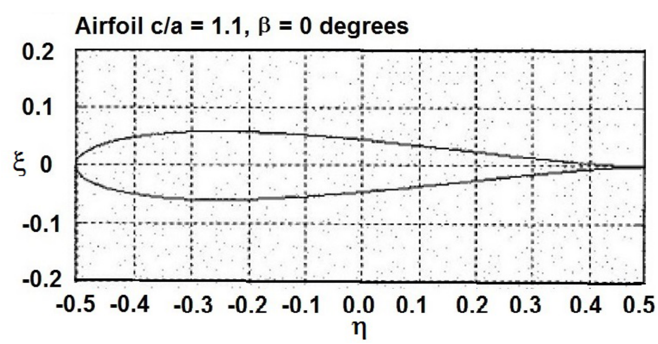

Figure 3: Joukowski airfoil shape for $c/a = 1.1$ and $\beta = 0°$.

[b] The following figures demonstrate how the lift coefficient, C_L, and the lift slope, $dC_L/d\alpha$ vary with the airfoil parameters. It can be seen that C_L increases almost linearly with c/a, the effect being more dominant at larger angles of incidence. The curves for $dC_L/d\alpha$ versus α are shifted upwards with increasing values of c/a. Also $dC_L/d\alpha$ has a significant dependence on the thickness even at small angles of incidence.

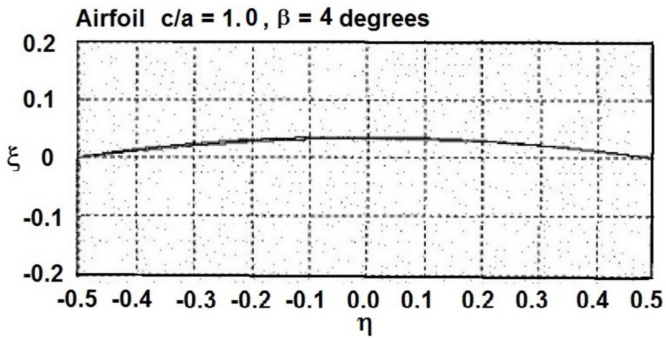

Figure 4: Joukowski airfoil shape for $c/a = 1.0$ and $\beta = 4°$.

It should also be noted that the curves for C_L and $dC_L/d\alpha$ versus α are shifted to the left with increasing β and that the angle of incidence at which $C_L = 0$ occurs at $\alpha = -\beta$. Also note that maximum value of $dC_L/d\alpha$ occurs at the same angle of incidence for a range of c/a values, at least at small angles of incidence.

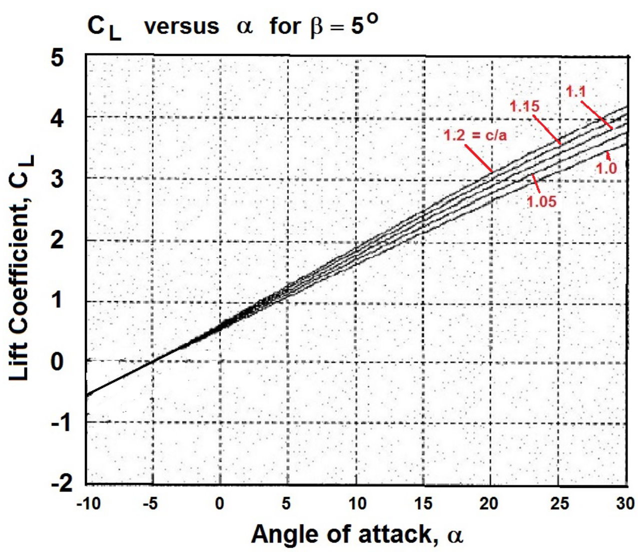

Figure 5: The lift coefficient, C_L, as a function of the angle of incidence, α, for the Joukowski airfoil with $\beta = 5°$ and various values of c/a.

[c] The following figures present examples of the variation of the pressure coefficient, C_p, on the suction and pressure surfaces of the Joukowski airfoils with $c/a = 1.1$ and $\beta = 5°$ at an angle of incidence of $\alpha = 5°$.

[d] The variation of the pressure coefficient on the foil surface.

[e] See Section (Bmbe).

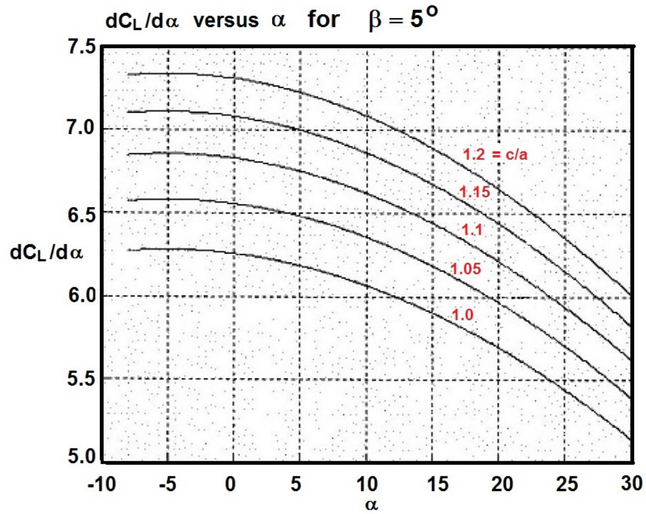

Figure 6: The lift slope, $dC_L/d\alpha$, as a function of the angle of incidence, α, for the Joukowski airfoil with $\beta = 5°$ and various values of c/a.

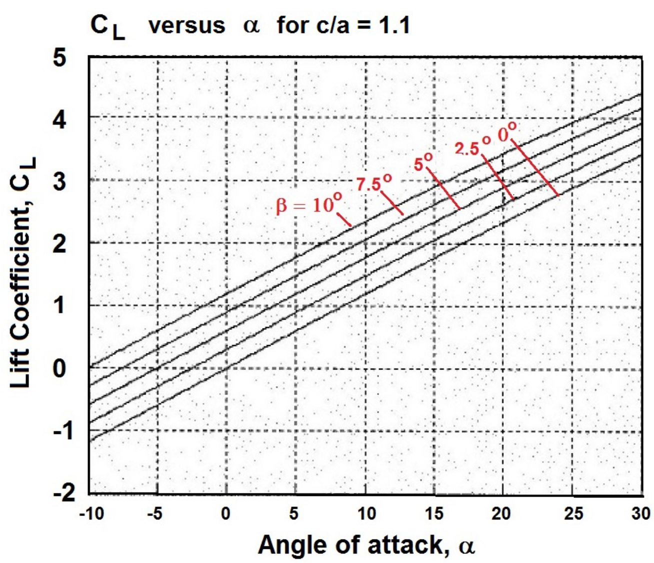

Figure 7: The lift coefficient, C_L, as a function of the angle of incidence, α, for the Joukowski airfoil with $c/a = 1.1$ and various values of β.

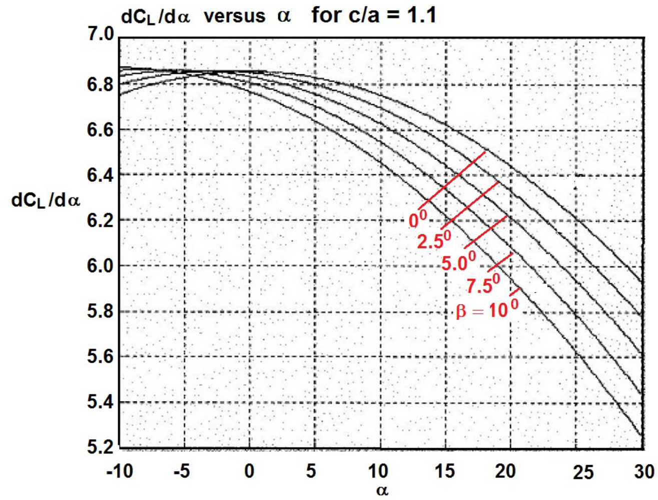

Figure 8: The lift slope, $dC_L/d\alpha$, as a function of the angle of incidence, α, for the Joukowski airfoil with $c/a = 1.1$ and various values of β.

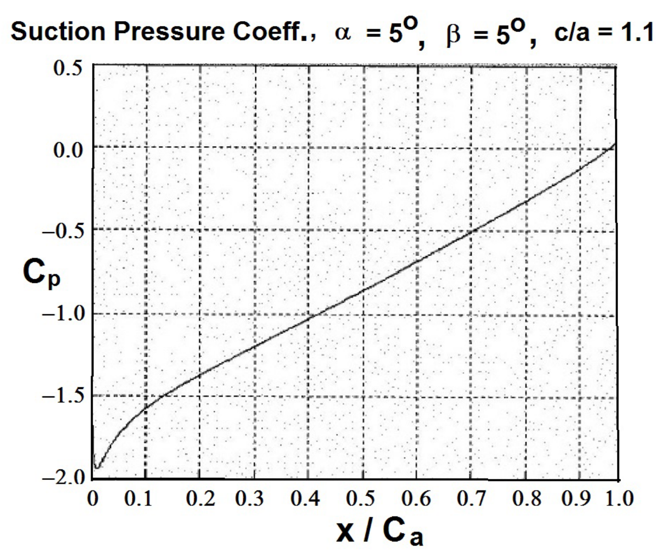

Figure 9: The variation of the pressure coefficient, C_p, on the suction surface of a Joukowski airfoil with $c/a = 1.1$, $\beta = 5°$ at an angle of incidence of $\alpha = 5°$. Here it is plotted versus the horizontal coordinate, ξ, scaled to the chord length, c_a.

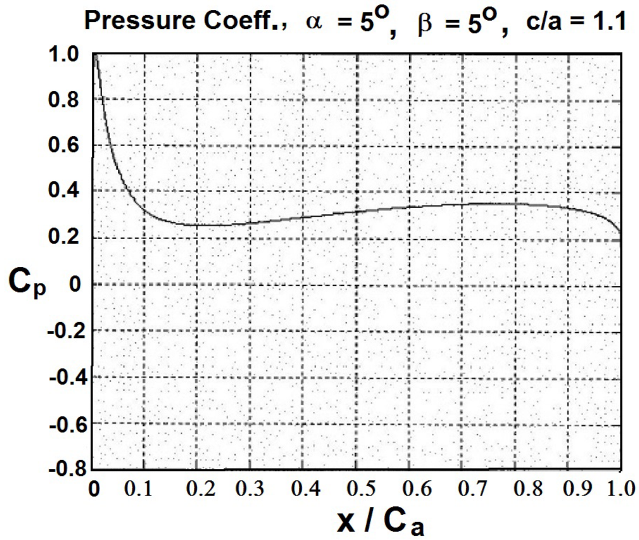

Figure 10: The variation of the pressure coefficient, C_p, on the pressure surface of a Joukowski airfoil with $c/a = 1.1$, $\beta = 5°$ at an angle of incidence of $\alpha = 5°$. Here it is plotted versus the horizontal coordinate, ξ, scaled to the chord length, c_a.

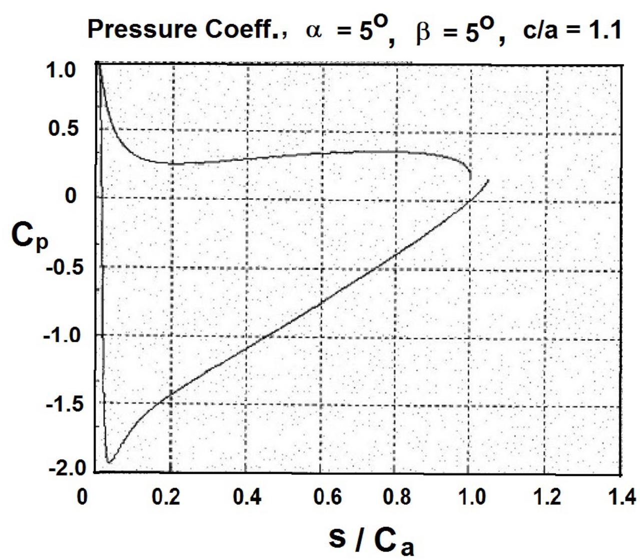

Figure 11: The variation of the pressure coefficient, C_p, on the suction and pressure surfaces of a Joukowski airfoil with $c/a = 1.1$, $\beta = 5°$ at an angle of incidence of $\alpha = 5°$. Here the pressure coefficients are plotted versus the developed surface distance from the front stagnation pointdishorizontal coordinate, ξ, scaled to the chord length, c_a.