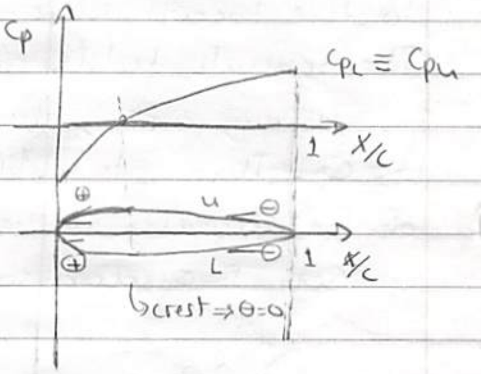
An explanation on why neither camber nor thickness distribution contribute to Lift, in the case of supersonic linearized potential flow.

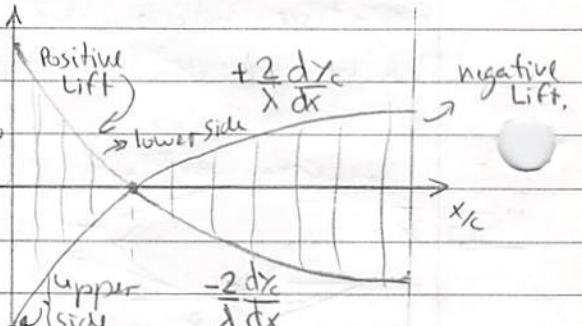
a) First, we tackle the case of the thickness distribution, which is simpler. As we all know, this distribution is intrinsically symmetric. Therefore we must have, according to page 16:

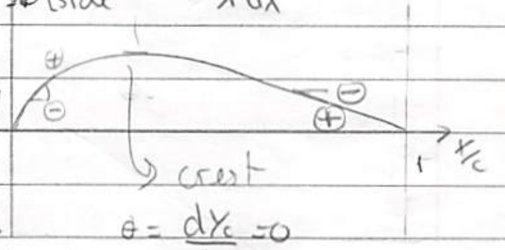


Owing to the symmetry, both curves C_{pu} and C_{PL} are exactly the same, that is, they must fall on top of each other and, thus, there can be no local nor net pressure difference:

$$C_{PL}\left(\frac{x}{c}\right) - C_{Pu}\left(\frac{x}{c}\right) = 0$$

b) When it comes to the camber line, we must have:
In principle the are between the curves Y_c' and $-Y_c'$ is not zero, and we can even see that the fore portion of the camber line should yield a positive contribution, while its aft part should give a negative contribution to it. That is: the local difference $(C_{PL} - C_{Pu})$ is not zero. A question then arises as to whether there is anything that would ensure that the two contributions should always cancel each other out.





As it turns out, there is such a "thing".
The reason why those contributions cancel out is because:

$$C_L = \frac{-2}{\lambda}\int_0^1 \left[\left.\frac{dY_c}{dx}\right|_L + \left.\frac{dY_c}{dx}\right|_u\right] d(x/c) = \frac{-4}{\lambda}\int_0^c \frac{dY}{dx}\,dx = -\frac{4}{\lambda}\left[\cancelto{0}{Y_c(c)} - \cancelto{0}{Y_c(0)}\right] = 0$$

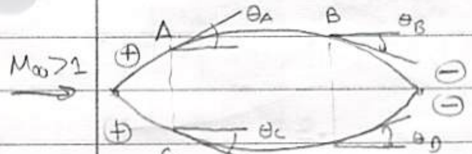
$$C_p = \frac{2\theta}{\sqrt{M_\infty^2 - 1}} \Rightarrow \boxed{C_p = \frac{2}{\sqrt{M_\infty^2-1}} \left.\frac{dy}{dx}\right|_s} \quad \text{F waves} \tag{35}$$

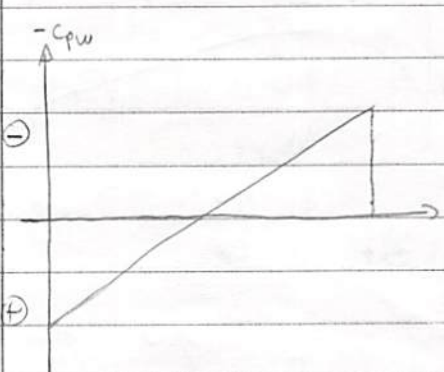
This is the linearized supersonic surface pressure coefficient, and it shows that Cp is directly proportional to the local surface inclination with respect to the freestream. The formula holds for any slender 2-D shape.

In any case, the above expression was derived by setting $G=0$. Thus, it holds for a surface generating a family of left-running waves (F) → i.e. the top surface. Now if we set $F=0$, the surface pressure coefficient becomes

$$C_p = \frac{-2\theta}{\sqrt{M_\infty^2 - 1}} \Rightarrow \boxed{C_p = \frac{-2}{\sqrt{M_\infty^2-1}} \left.\frac{dy}{dx}\right|_s} \quad \text{G waves} \tag{36}$$

which holds for right-running waves (G), the bottom surfaces. In both eqs (35) and (36) the angle θ (local slope) is measured positive above the local flow direction and negative below the local flow direction. The sign convention can be illustrated by the biconvex airfoil example below.





That is, there is no real need to worry about the formal sign conventions. For, if the surface is a compression surface, Cp will be positive, no matter whether it is on top or bottom. Similarly, an expansion surface will yield a negative Cp. This leads to an important difference between subsonic and supersonic potential flows: Recall that for $M_\infty < 1$ a 2-D body experiences no drag. For $M_\infty > 1$, however, we see that the Cp is positive on the front surfaces and negative on the rear surfaces. Consequently, there is a net pressure imbalance