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DEPARTMENT OF AEROSPACE AND MECHANICAL ENGINEERING

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NACA FOUR-DIGIT WING SECTIONS

The NACA four-digit airfoils have similar thickness distribution and piecewise parabolic mean camber line.

1. Consider an airfoil of chord length c along the x-axis. Then, the thickness distribution, y_t, is given, for $0 < x < c$, as

$$\frac{y_t}{c} = \pm 5t \left\{0.2969\sqrt{\frac{x}{c}} - 0.1260(\frac{x}{c}) - 0.3516(\frac{x}{c})^2 + 0.2843(\frac{x}{c})^3 - 0.1015(\frac{x}{c})^4\right\} \qquad (1)$$

The maximum thickness occurs at 30% of the chord from the leading edge. That is, at $x = 0.30c$, y_t is maximum and equal to $0.5tc$. t is usually referred to as the *thickness ratio* and is equal to the ratio of maximum thicness to the chord length, i. e.,

$$t = 2\frac{Max\{y_t\}}{c}$$

The radius of curvature at the leading edge is $r_{l.e.} = 1.1019t^2$

2. The mean camber line, y_c, is made of two parabolas :

(i) Forward of the maximum ordinate

$$\frac{y_c}{c} = \frac{m}{p^2}[2p(\frac{x}{c}) - (\frac{x}{c})^2] \qquad (2)$$

(ii) Aft of maximum ordinate

$$\frac{y_c}{c} = \frac{m}{(1-p)^2}[(1-2p) + 2p(\frac{x}{c}) - (\frac{x}{c})^2] \qquad (3)$$

pc is the chord wise position of maximum camber, and m is the *camber ratio*, i. e.,

$$m = \frac{Max\{y_c\}}{c}$$

3. The NACA four-digit airfoils are represented by NACAxxxx. The last two digits represents the airfoil maximum thickness. The first digit represents the the maximum mean camber. The second digit represents the location of the maximum camber. Thus NACA0012 represents a symmetric airfoil with 12% maximum thickness, i.e., t=0.12. NACA2408 is an airfoil with a maximum mean camber of 2% located at a distance $0.4c$ from the leading edge, i.e., $t = 0.12, m = 0.02,$ and $p = 0.4$.