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STEADY AND UNSTEADY ANALISYS OF AERODYNAMICS WING SECTIONS AT ULTRA-LOW REYNOLDS NUMBERS (RE<10000)

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Abstract. The purpose of this study is to describe phenomena that manifest themselves in flows where Reynolds numbers are ultra-low (*Re* <10000). To accomplish this study, mathematical techniques capable of solving the Navier-Stokes equations for laminar-incompressible flows are used. It is noted that a solver based on the Finite Element Method provides an appropriate resolution procedure, however, it must also be noted that because of the incompressible assumption the character of the continuity equation goes from hyperbolic to elliptic. Because of this, a *Fractional Step* method which evolves toward a semi-implicit temporal integrator is used, and to handle the convective and pressure terms the so called *Orthogonal Sub-grid Scale(OSS)* algorithm is applied. In addition, the motion of the finite elements computational mesh through solving the Poisson equation and optimizing each element metric, is implemented. Basic useful results describing the behavior of several 2D geometries at steady ultra-low Reynolds flows, are presented. Different geometric parameters like thickness ratio, mean lines camber, shape of leading edge, etc. are changed and its effects evaluated. Flow detachment features and their impact on main aerodynamic properties are assessed. Wing sections performing typical unsteady flights like heaving, pitching, flapping and hovering are also analyzed, and its aerodynamic properties in terms of Strouhal numbers, reduced frequencies and Reynolds numbers determined.