AERONAUTICAL ENGINEERING FACULTY

NRC: 20529 AERODYNAMICS

VLM Classwork – Professor: Juan Pablo Alvarado P.

Due: September 18th –10:00 am/11:40 am

Directions: This classwork can be completed with any other individual's help. This includes help from other students (whether or not they are taking Aerodynamics), other faculty staff, people on the Internet, etc. You can use your books, class notes, library resources, etc. You must provide the numerical or text answer as asked in each problem or question. **The procedure and answer will be graded following the grade breakdown table below**. Answers in the English language are compulsory for this classwork. Answers with wrong or no units will be penalized. The percentual error of the numerical answers is 5.0%. Absolutely no late classwork will be accepted.

This classwork must be done in groups of a maximum of three students.

Grade breakdown:

Problem No.	**Percentage [%]**	**Value**	**Grade**
1	20	1	
1-procedure	5	0.25	
2	20	1	
2-procedure	5	0.25	
3	20	1	
3-procedure	5	0.25	
4	20	1	
4-procedure	5	0.25	
TOTAL GRADE			

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1. For a wing with an aspect ratio of 4.2, wing area of 0.2 [m^2], and taper ratio of 0.45, use of VLM (use four control points per semi-span) mathematical solution to obtain the values of the lift coefficient for the following leading-edge sweep angles and plot the results in a graph comparing both parameters:

Λ_{LE} [deg]	$C_{L,w}$
3.5	
7.0	
10.0	
35.0	

2. Using the VLM mathematical solution (4 control points per semi-span), calculate the lift coefficient for the swept wing of the example explained during the lectures. The only differences are that the wing has an aspect ratio of 8, and the wing area is 0.125 [m^2]. How does the lift coefficient for this aspect ratio (8) compare with that for an aspect ratio of 5? Conclude about the change in the lift coefficient when the aspect ratio varies.

3. Using the VLM mathematical solution (4 control points per semi-span), calculate the lift coefficient for the swept wing of the example explained during the lectures, a taper ratio of 0.5 and a wing area of 0.2 [m^2], an uncambered section, and the quarter chord swept 45°. Since the taper ratio is not unity, the leading edge, the quarter-chord line, the three-quarter-chord line, and the trailing edge have different sweep angles. This should be considered when defining the coordinates of the horseshoe vortices and the control points.

4. Using the VLM mathematical solution (4 control points per semi-span), calculate the lift coefficient for a forward swept wing in which a quarter chord is swept forward 45°, the aspect ratio is 3.55, the wing area is 0.2817 [m^2], and the taper ratio is 0.5. The airfoil section (perpendicular to the quarter chord) is a NACA 64A112. For this airfoil section $\alpha_{L=0}$ = -0.94 and $c_{l,\alpha}$ = 6.09 [1/rad]. Assume that the wing is planar to apply the no-flow boundary condition at the control points. Develop a graph of the lift coefficient versus the angle of attack.