# Chapter 5
# Finite Wing Theory

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## ABSTRACT

*Wing design is a very complicated and intricate issue. It is not feasible to cover everything in this chapter; however, it is possible to discuss some of the essential ideas that underpin design for high lift and low drag. Lift may be increased in four ways for fixed air characteristics and free-stream speed: increased wing area, increased angle of attack, increased camber, increased circulation through the use of high-momentum fluid. One of the most important applications of potential flow theory was the study of lifting surfaces such as aircraft wings, since the boundary conditions on a complex geometry can significantly complicate any attempt to tackle the problem via analytical techniques, which involves some simplification assumptions in order to arrive at a solution. These assumptions will be related to the concept of three-dimensional thin wing issues in this chapter.*

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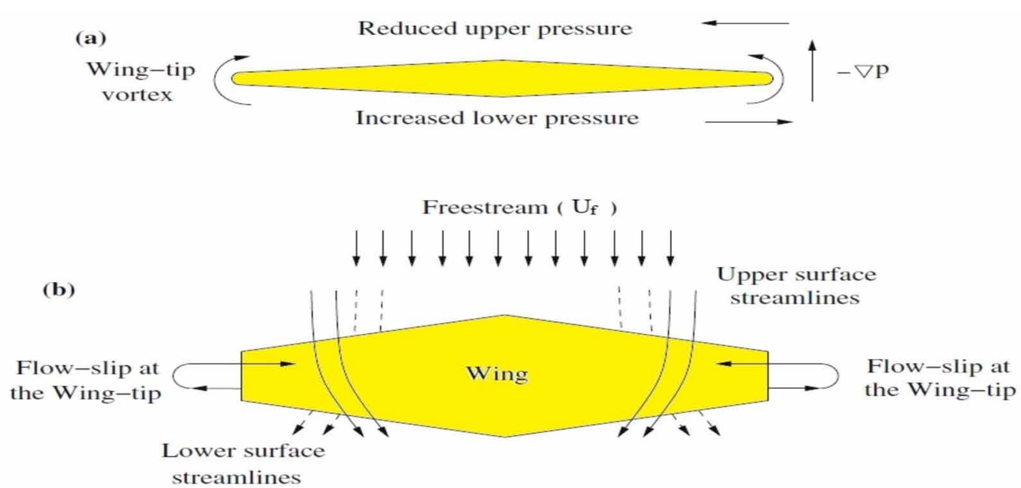
## 1 INTRODUCTION

Wing design is a very complicated and intricate issue. It is not feasible to cover everything in this article, however, it is possible to discuss some of the essential ideas that underpin design for high lift and low drag. The lift may be increased in four ways for fixed air characteristics and free-stream speed: Increased wing area, Increased angle of attack, Increased camber, Increased circulation through the use of high-momentum fluid. One of the most important applications of potential flow theory was the study of lifting surfaces such as aircraft wings since the boundary conditions on a complex geometry can significantly complicate any attempt to tackle the problem via analytical techniques, which involves some simplification assumptions in order to arrive at a solution. These assumptions will be related to the concept of three-dimensional thin wing issues in this chapter.

## 2 LIFT AND DRAG ESTIMATION IN A FINITE WING

We know an aeroplane is in the air because of the lift created by its wings as a result of higher pressure on the lower (bottom) surface and lower pressure on the suction (top) surface. The lift is produced by the pressure differential between the lower and higher surfaces. It also causes the flow to curve around at the wingtips as it is driven from the pressure surface to the suction surface. As a result, there will be a spanwise component of flow from the wingtip to the wing root, causing the streamlines on the upper surface to bend toward the wing root, as seen in Figure 1. Similarly, the spanwise component of flow on the bottom surface will be in the direction of the wing root to the wingtip. As a result, it is clear that the flow across the wings is three-dimensional, and their aerodynamic characteristics differ significantly from those of their airfoil sections (Figure 2).

*Figure 1. Front and top views of a three-dimensional wing's flow pattern*



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