

1.1 Introduction:

The most crucial stage of any design process is to arrive at the correct set of requirements for the aircraft, which ensure that the final design meets the requirements, and to aid in future product development.

In the field of aircraft design, the designer should build his designs on the basic assumption with consideration of certain specifications and requirements established by potential user or manufactures in addition by trial to obtain pioneering innovative new ideas and technology. In the domain of aircraft design and air space satellites the designer need very high specifications of safety and reliability which are not found in the other fields of transports because deal with space results is a very high risk.

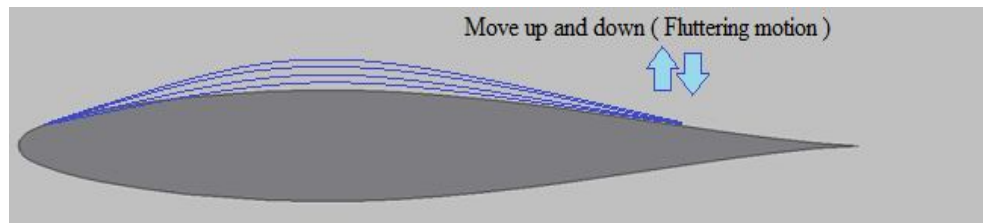
In addition there should be essential requirements like weight, stiffness; hardness of structural, economical and airworthiness ...etc requirements.

The wing is the most important lift-producing part of the aircraft, which making it significant in aircraft design. Wing Also carry the fuel, undercarriage and engine for the airplane.

Wings vary in design depending upon the aircraft type and its purpose. Most airplanes are designed so that the outer tips of the wings are higher than where the wings are attached to the fuselage. This upward angle is called the dihedral and helps keep the airplane from rolling unexpectedly during flight (Lateral stability).

The Flexible Wing is that wing which made by smart materials with actuators can be changed its shape depending on the situation in order to optimize aerodynamic efficiencies and aircraft control.

Or wing made with very loose or slack membranes whose configurations in flight are determined primarily by the aerodynamic forces on the membranes and the reactions from the load suspension system (figure1.1)



Figure(1.1): Flexible wing fluttering motion.

At conventional aircraft (rigid wing), the pressure distribution is determined by the wing shape and free-stream flow properties. For a flexible wing, its shape changes under aerodynamic load, and, consequently, the angle of attack and surface pressure distribution will change along with the flight environment. In order to shed light on the aerodynamic characteristics of membrane wing, one needs to solve coupled fluid-solid dynamics to track both the shape change and the pressure distribution on the wing shape. [1]

In combat missions, the way the aircrafts used nowadays in Air Force needs to be changed. New targets have emerged and new enemy's strategies have been developed. Enemies make their targets smaller and hide them to prevent detection. We also face difficulty in attacking those targets because of complexity of air control in certain areas. In this situation the aircraft need more time, information and energy to detect and attack targets. In other words, the Air Force needs to make aircraft that provide flexibility and versatility to deal with these kinds of targets in a cost effective manner. [2]

1.2 Problem statement:

The conventional wing has a limit of lift coefficient value which should be under maximum lift coefficient value ($C_{L_{MAX}}$) at normal conditions. In this project the fluttering surfaces has been implemented to improve the aerodynamic characteristics of the wing which leads to increase maximum lift coefficient value (and that means increase the stall angle of attack value).

1.3 Methodology:

This project consist of three parts, First part Includes Selecting the airfoil type, Manufacturing the models in form of Aluminum material (conventional wing) and “glass fiber and carbon fiber” (flexible wing),the second most important part is consist of the theoretical analysis, the experimental investigation by using wind tunnel test, and the third part is study and determines the effect of flexible wing on the performance of the aircraft.

1.4 Project objectives:

- ❖ Studying the flexible wing’s material.
- ❖ Production of flexible wing from different type of material (glass fiber, carbon fiber, smart material, and aluminum).
- ❖ Test the product wings on the wind tunnel and gain the lift and drag data.
- ❖ Comparison between the product wings data, the conventional wings data.
- ❖ Study and determine the effect of flexible wing on the performance of the aircraft.

1.5 Research outlines:

- ❖ Chapter One: Introduction
- ❖ Chapter Two: Literature review this chapter includes previous study of flexible wing flow separation by using smoke-wire flow visualization method and compares these results with rigid wing.
- ❖ Chapter Three: Flexible wing materials .This chapter consists of definitions of different types of materials that may be used in flexible wing fabrications, its characteristics, advantages and disadvantages.
- ❖ Chapter Four: The fabrication-Experimental Simulation Works. This chapter includes manufacturing the models, testing the models in wind tunnel.
- ❖ Chapter Five: Calculation. This chapter contains performance calculation for the rigid and flexible models.
- ❖ Chapter Six: Results and discussions
It consists of two parts:-
Part 1: Wind tunnel tests results and discussions.
Part 2: Performance results and discussions.
- ❖ Chapter Seven: Conclusion and recommendations