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Numerical Investigation over Dimpled Wings of an Aircraft

A. Arunkumar[1], T. S. Gowthaman[2], R. Muthuraj[3], S. Vinothkumar[4], K. Balaji[5]
[1,2,3,4] Student, [5]Asst.Pprofessor, Department of Aeronautical Engineering
Karpagam Institute of Technology, Coimbatore, Tamil Nadu, India.

Abstract: ***The main intention of aircraft aerodynamics is to develop the aerodynamic characteristics and maneuverability of the aircraft. The airfoil which contains dimples will have comparatively a lesser amount of drag than the plain airfoil. Introducing dimples on the aircraft wing will create turbulence by creating vortices which delays the boundary layer separation resulting in reduce of pressure drag and also raise in the stall angle. This project includes both computational and experimental analysis of dimple effect on aircraft wing, using NACA 6321 airfoil. The dimples on the surface of the aerofoil is circle, heart, elliptical ,which chosen for analysis .The aerofoil which is tested under the inlet velocity at the different angle of attack. From the experimental it has been observed that the flow separation can be belated by using dimples on the aerofoil on the aircraft and thereby they reducing the drag by applying the dimple effect over the aircraft wing .then the intention of the project which are carried out to the numerical analysis by using the CFD with which determine the dimples on the airfoil . From which they result in the wake area which raise in pressure drag at the higher angle of attack which is due to the flow separation .The main aim of the project which involves in reducing the take off distance by attaining the high coefficient of the lift at the higher angle of attack.***

Keywords: - CATIA, CFD, Lift, NACA6321, Drag

I. INTRODUCTION

An aircraft is basically a machine which can able to fly by gaining support from the air with in the earth atmosphere. The interaction between the aircraft and air termed as aerodynamics which deals with the forces and motion of aircraft through the air. A Enhancing aerodynamic efficiency (L/D) is one of the key parameter that determines performance of an aircraft. Improved aerodynamics is critical to both commercial and military aircraft.

Consider a golf ball has dimples have been inspiring engineers in the field of vehicle aerodynamics considering its effect on drag which has been reduced on spinning bodies. A golf ball with a dimpled surface can travel higher and further than a smooth surfaced golf ball when subjected to equal force. The dimples on golf balls bring about turbulence at lower Reynolds number, providing extra momentum or energy to the boundary layer which causes delay in flow separation. This phenomenon causes slighter wake areas or swirling flow regions behind the ball, thus reducing the total drag.

The surface modifications which are being considered in the given study of dimples with types and shapes. Till now these have been ignored because dimples help in reduction of drag pressure. In case of aerodynamic bodies pressure drag is very small compared to bluff bodies. An airfoil is an aerodynamic body so dimples do not have an effect on its drag much at zero angle of attack, but while airfoil attains some angle of attack, wake formation starts due to boundary layer separation. Application based on dimples on the aircraft wing model works in same manner as vortex generators. This also assisted in Lift of the aircraft. Most importantly this can be quite effective by varying the angle of attacks and also can change angle of stall to a great extent. Flow separation begins to occur at small angles of attack even if the flow is attached over the wing is still dominant. As angle of attack increases, the separated regions on the top of the wing raise in size and hinder the wing's ability to create lift. increases in angle of attack produce less lift and vastly more drag.

II. LITERATURE REVIEW

[1] E.Livya,G.Anitha and P.vaali aerodynamic analysis of dimple effect on aircraft wing The main objective of aircraft aerodynamics is to enhance the aerodynamic characteristics and manoeuvrability of the aircraft. This improvement includes the decrease in drag and stall phenomenon. The airfoil which contains dimples will have comparatively less drag than the plain airfoil [2] Mohanasaravanan P.S flow analysis around the dimple wing on aircraft Change in aerodynamic characteristics of an airfoil by

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applying certain surface modifications in form of dimples. Our aim of the project is to design a wing with dimples on the upper surface of the wing and analyse the results using design software ICEM CFD and CFX in ansys.

[3]Bhadri Rajasai, Ravi **Tej,** Aerodynamic effects of dimples on aircraft wings concerned with analysis of the turbulent flow over dimpled aerofoil profiles. Dimples of varying aspect ratio are used to study the effects on the skin-friction dragand lift. An external flow study was performed using ANSYS FLUENT.

[4] Shaik Mohamed Nagutha G,Sacraties A **,** Numerical Analysis of Effect of Dimples on Aerodynamics of an Airfoil. Airfoil is a shape that enhance the aerodynamics and manoeuvrability of an aircraft . Our research is to carryout numerical analysis using CFD to verify the produce of Dimples on Aerodynamics of an airfoil. The wake region, increases the pressure drag at higher angle of attack which is due to flow separation.

[5] Deepanshu Srivastav Flow Control over Airfoils using Different Shaped Dimples first surface modifications that are considered here are outward and Inward dimples on the wing model. A 2-Dimensional computational fluid dynamics CFD is prepared on both using k-w turbulence model, there after based on its results the better of the two is chosen. After Choosing the better dimpled configuration, different created dimples are tested and compared to the flat airfoil model. This CFD analysis is done in 3-D by taking a segment of the airfoil with one dimple on it. A comparative study showing variance in lift and drag of modified airfoil models at different angle of attacks is done.

III. DESIGNING

A. Design Parameters

The dimple parameter are taken and the wing parameters are shows in given below

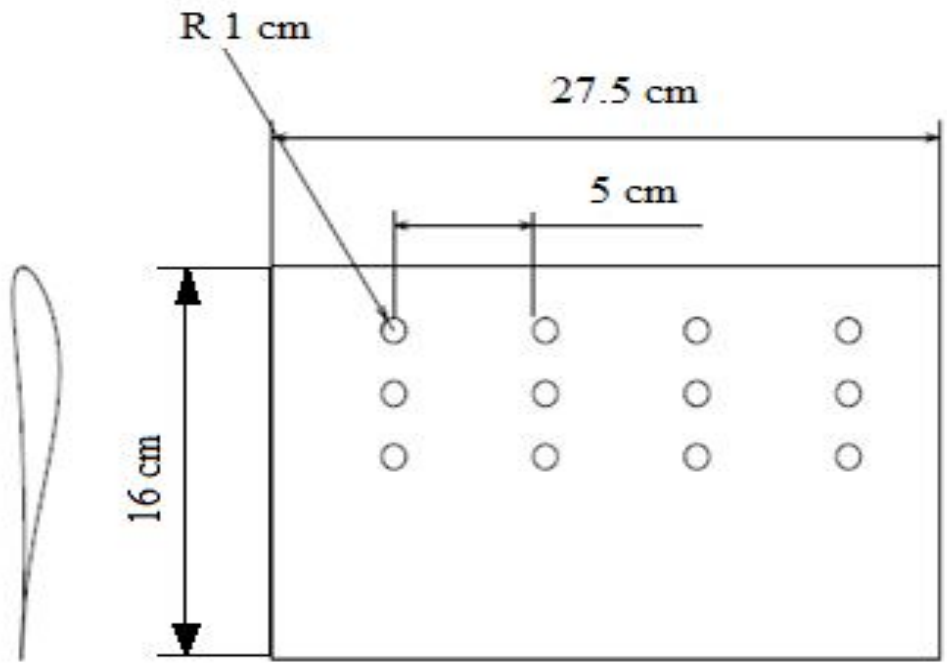


Fig.1:NASA 6321 Aerofoil with dimples and parameter

B. Modelling In Catia

CATIA is the software used for designing the shapes and structural parts of the models. Using the above specifications the wing is designed using CATIA in the 3D view. The model with outer structure and inner parts are designed.

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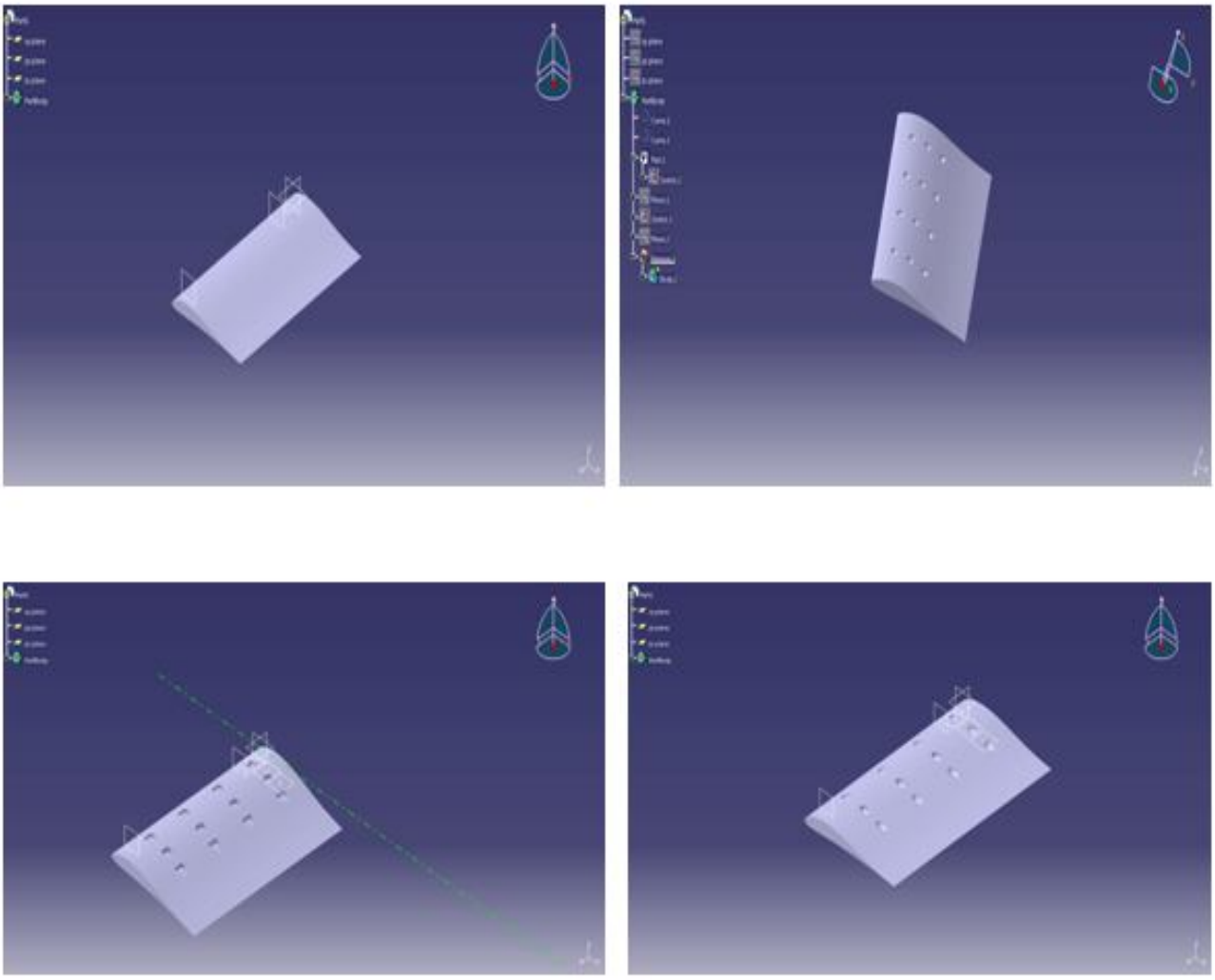


Fig.2: Design of NASA 6321 Airfoil with dimples

IV. NUMERICAL ANALYSIS

A. *Methodology*

The simulation procedure and steps followed were already been introduced in chapter 1. In this section we will stick to the rules of CFD solving technique and apply them to solve and to understand the flow around cylinder possessing rough surface. Before jumping into the solution we must be doctor to understand the nature of the problem that we are dealing with and then we look for the fittest method or model to eliminate the disease. The current paper deals with the flow around the circular cylinder of different diameter, length and varying surface roughness. For the flow fluid air and water are taken into consideration of varying velocity to obtain the drag force imposed on the cylinder. To do this we follow the stepwise procedure starting with identification of objective or problem and going on to the proceeding steps as Pre-processing, solver which ends with Post-processing.

B. *Pre-Processing*

The process involves the generation or insertion of domain geometry used for calculation of force around the solids. All the modification like extruding the body, subtraction or addition process and generation of mesh are done over the domain.

C. *Normal Wing @10 Degree*

The analysis of the wing without dimples is analyzed in the ANSYS workbench and the result obtained from the analysis is

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1) Normal Wing @10 Degree:

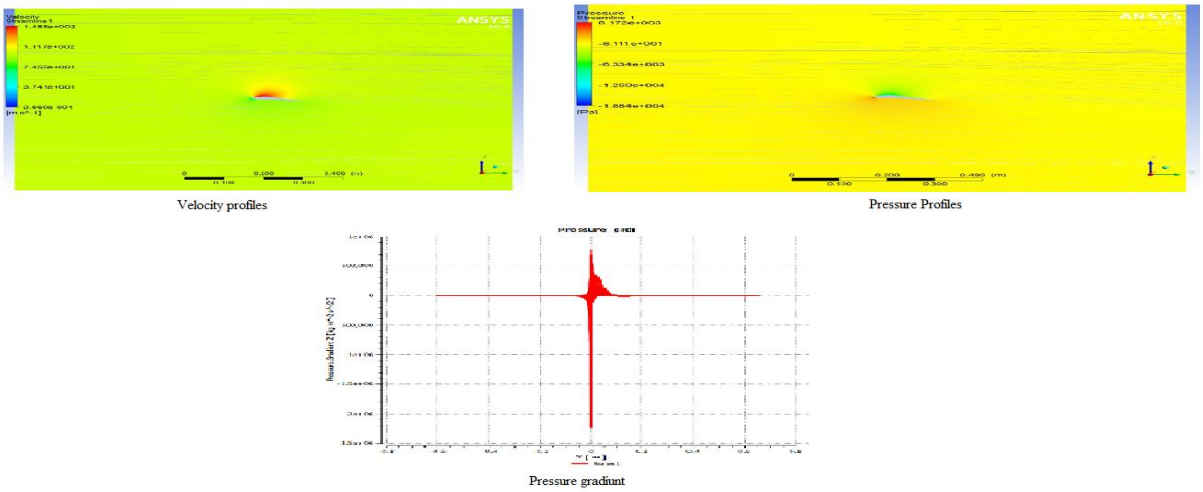


Fig.3: Analysis of NASA 6321 plain airfoil

D. Dimple Wing @ 10 Degree

Circle shape dimple

The analysis of the wing with circle dimples is analyzed in the ANSYS workbench and the result obtained from the analysis is displayed below

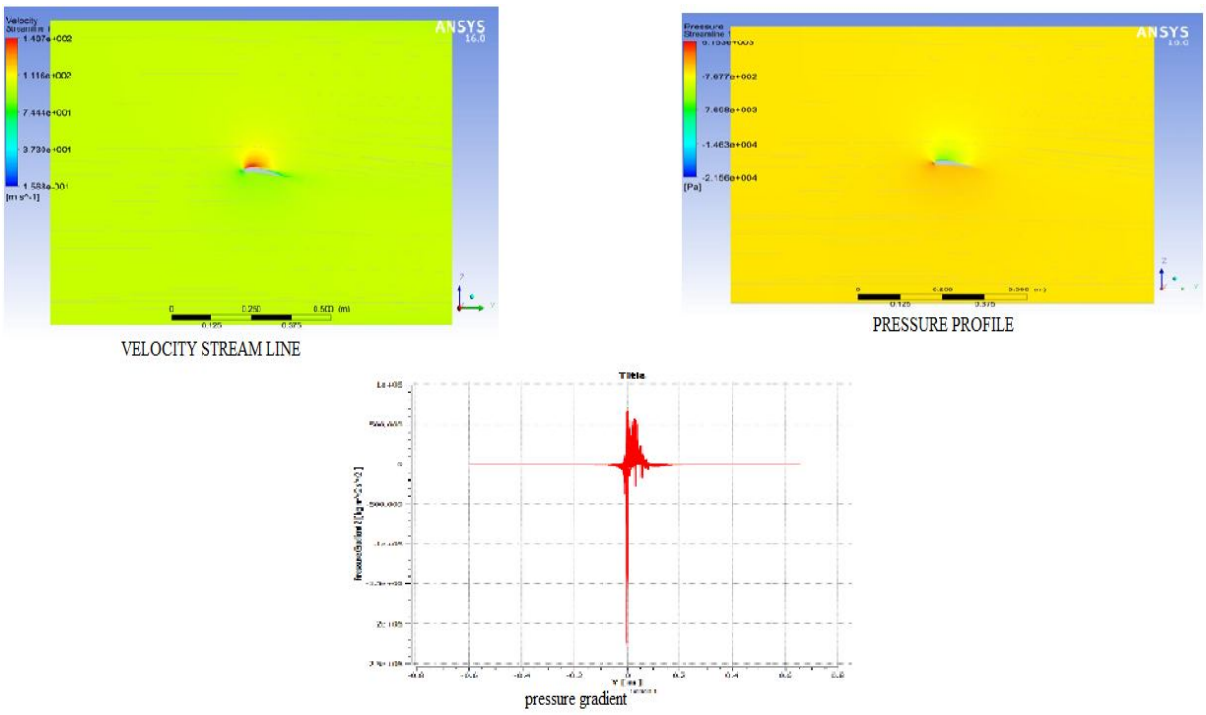


Fig.4**:**Analysis of NASA 6321 airfoil with circle shape dimple

E. Dimple Wing @ 10 Degree:

Ellipse shape dimple

The analysis of the wing with ellipse dimples is analyzed in the ANSYS workbench and the result obtained from the analysis is

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displayed below

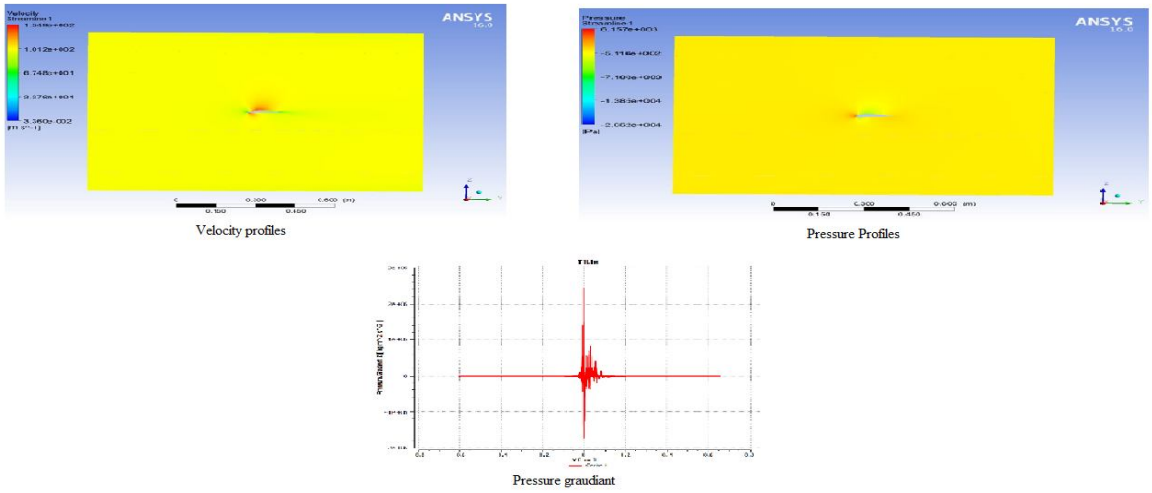


Fig.5:Analysis of NASA 6321 airfoil with ellipse shape dimple

F. Dimple Wing @ 10 Degree

Heart shape dimple

The analysis of the wing with heart dimples is analyzed in the ANSYS workbench and the result obtained from the analysis is displayed below

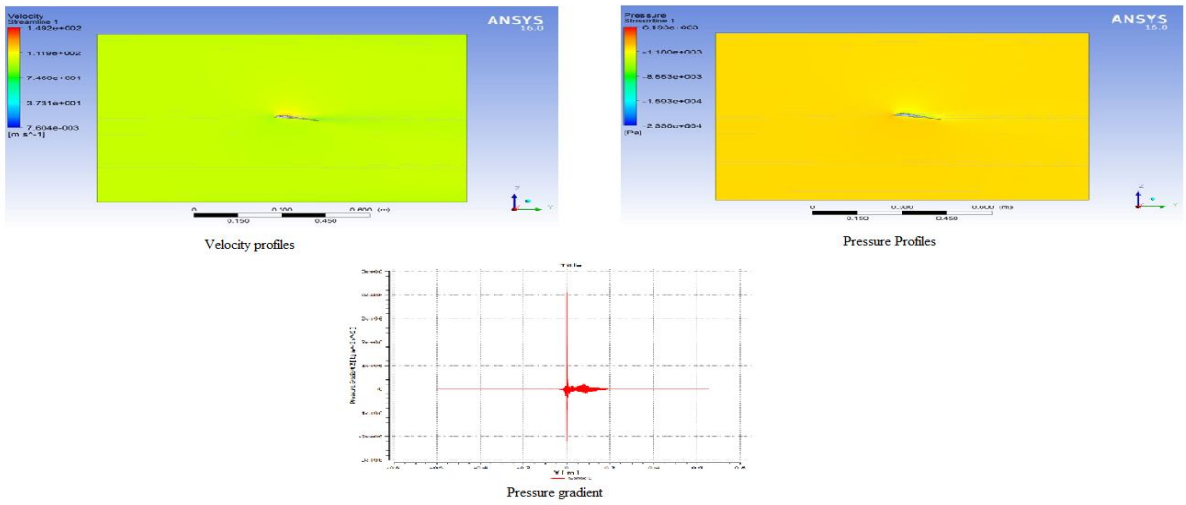


Fig.6:Analysis of NASA 6321 airfoil with Heart shape dimple

V. CONCLUSION

From the above discussion it is evident that the wing with dimples produces more lift and less drag than the wing without dimples. The readings are derived from the numerical analysis carried out by the designing and analyzing software's .By taking three dimple wing as reference circle, ellipse, heart. From that the circle dimple wing has been given high efficiency of lift

Degree	Normal wing (N)	Circle Shapes dimple wing(N)	Ellipse Shapes dimple wing(N)	Heart Shapes dimple wing(N)
10	2.37	3.1	2.89	0.44

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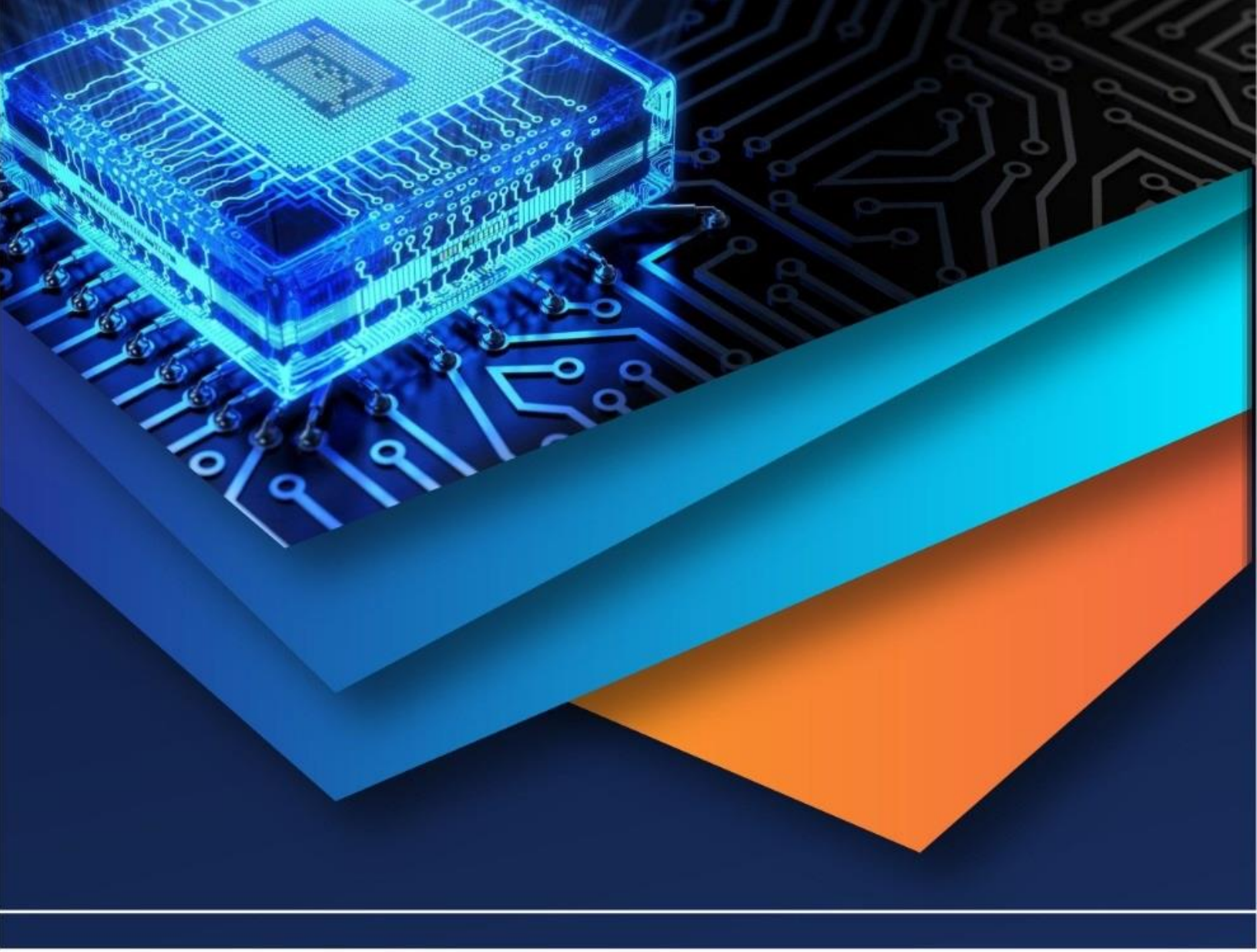
VI. ACKNOWLEDGMENT

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