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Performance Analysis of Winglet Using CFD

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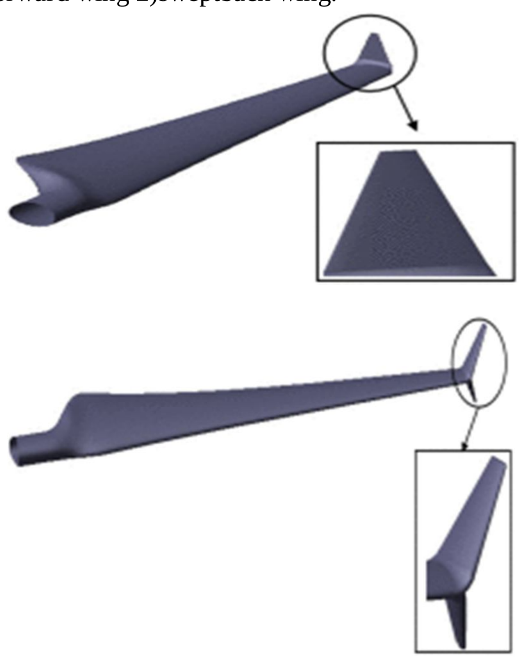
Abstract: The most noticeable features are WINGLET. These are wingtip extensions which reduced the lift induced drag and provide some extra lift. The determination of performance of various shaped WINGLETS on different types to reduce the induced drag by using ANSYS (fluent) by using the winglet reducing induced drag which is generated by lift, over wing due to pressure differences between upper and lower camber.

I. INTRODUCTION

Wing: it is a type of fin that produces lift, while moving through air or some other fluid. As such, wings have streamlined cross-_sections that are subject to aerodynamic forces and act as airfoils. Winglet: it is wingtip device which used to describe an additional lifting surface on an aircraft, like a short section between wheels on fixed undercarriage. types of
Winglets 1)scimitar 2)blended 3)trapezoidal 4)spiroid winglet 5)sharklet , in this project we are going to use blended and scimitar winglet.
Blended winglet: this type of winglet has a large radius and is designed with a smooth chord variation in the transition area where the wing joins the winglet.
Scimitar: this type of winglet refines the aerodynamic of the existing blended winglet on the Boeing 737NG family. In our project these two winglets analyzing with the 1)forward wing 2)sweptback wing.



II. LITERATURE SURVEY

Multi-Objective Shape Optimization:

1) The Pareto front between the wing aerodynamic drag and the wing structural weight for a wing equipped with a winglet.
2) In order to estimate the aerodynamic and structural characteristics of a non-planar wing, a quasi-three-dimensional aerodynamic solver is integrated with a quasi-analytical weight estimation method.

A. Induced drag and winglets

1) The induced lift is defined as the lift due to the velocities that the lifting vortices induce on themselves. The lift does not increase the induced drag

2) This has the same effect as decreasing the induced drag without changing the lift.
3) A simple method is given for the evaluation of the .the induced lift the rollup of the wake is not considered.
4) The results from several parameter variations are presented.

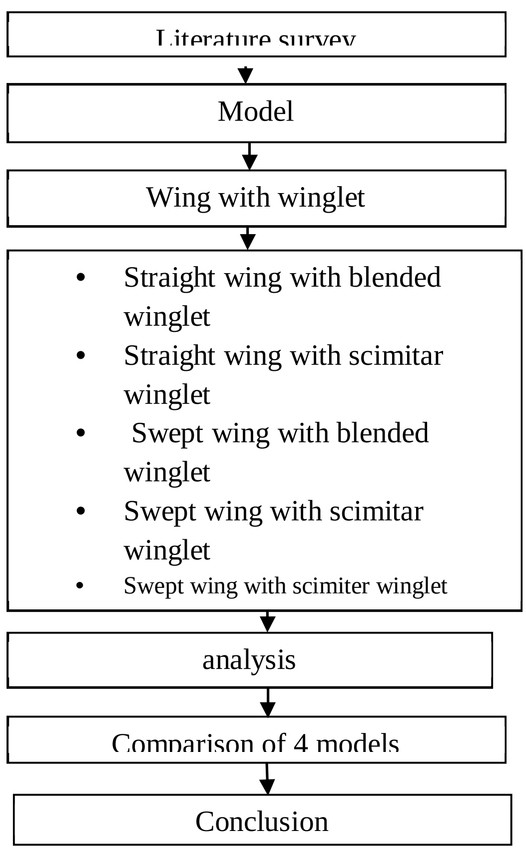
B. An inverse study to design the optimal shape and position for delta winglet vortex generators of pin-fin heat sinks:
1) This study using a general purpose commercial code CFD.
2) The results indicate that with the designed optimal vortex generators the cooling performance is indeed better than that with the original design vortex generators.

C. Improving the thermal hydraulic performance of a circular tube by using punched delta-winglet vortex generators:
1) Vortex generators is proposed in order to improve the thermal hydraulic performance for energy conservation.
2) It was found that the Nusselt number increase with the increasing attack angle and decreasing pitch of the delta-winglet vortex generators.

D. Effect of winglets induced tip vortex structure on the performance of subsonic wings:
1) This paper presents the comparative study of the effectiveness of the 3 different winglet designs in reducing lift induced drag by changing the number of vortices and vortex distribution at the wingtip
2) Computational simulation were performed on ANSYS (fluent) V15 using the Reynolds averaged Navier-stokes equations coupled with the k-ε SST turbulence model to study the three dimensional flow & vortex structure about the half wing**.**

E. Design and hydrodynamic analysis of horizontal axis tidal stream turbines with winglets:
1) Three horizontal axis tidal stream turbines (HATST) with winglets are proposed and investigated to enhance the energy conservation efficiency.
2) The power coefficient, the thrust coefficient, the pressure distribution and the tip vortex are analyzed**.**

III. WORK METHODOLOGY



A. Scimiter Winglet

Basic dimensions:

8 ft 2 inc (tall)

4 ft (wide at the base)

2 ft (narrowing at the tip) & add 5 ft to the tall

5 ft to the tall wing span.

Modified dimensions:

7 ft 1.8 inch (tall)

3.5 ft (wide at the base)

1.5 ft (narrowing at the tip) & add 5 ft to the tall

4 ft to the tall wing span

Fig.5.1 Swept Wing With Scimitar Winglet

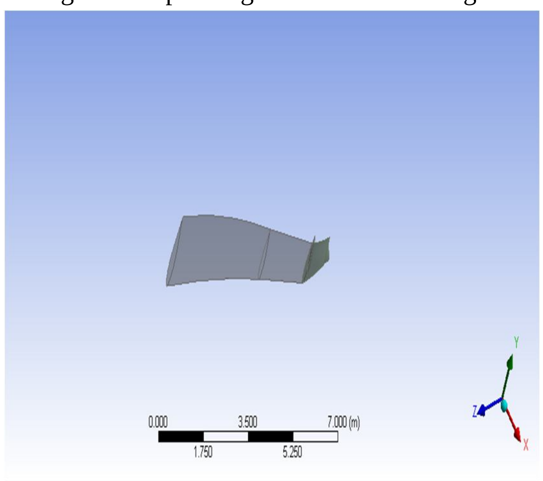


Fig.5.2 Straight Wing With Blended Winglet

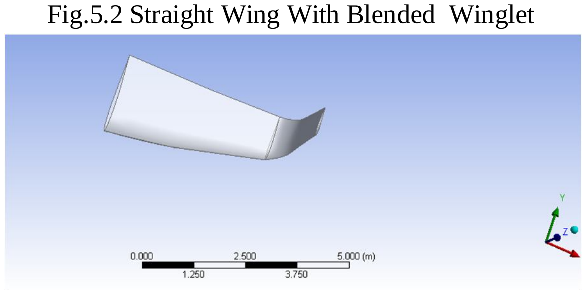


Fig.5.3 Straight Wing With Scimitar

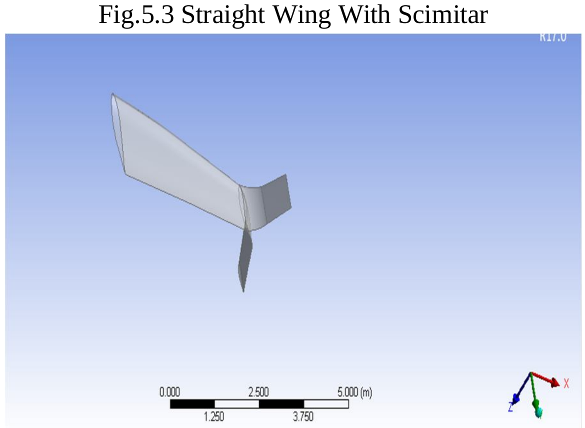
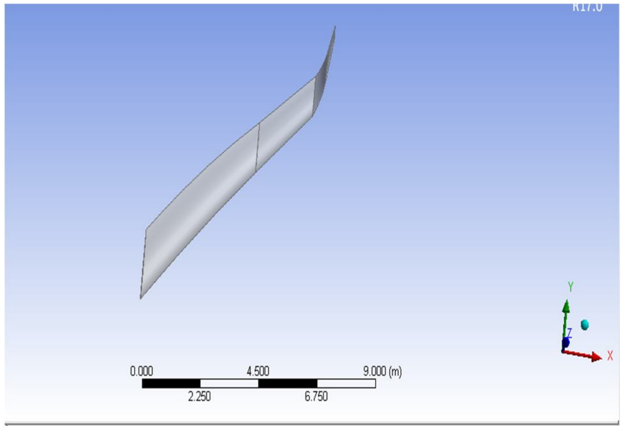


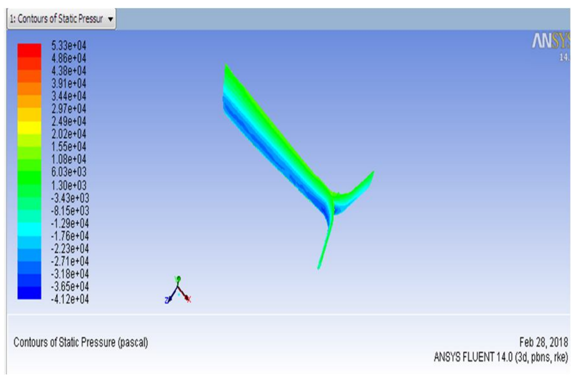
Fig.5.4 Swept Wing With Blended Winglet



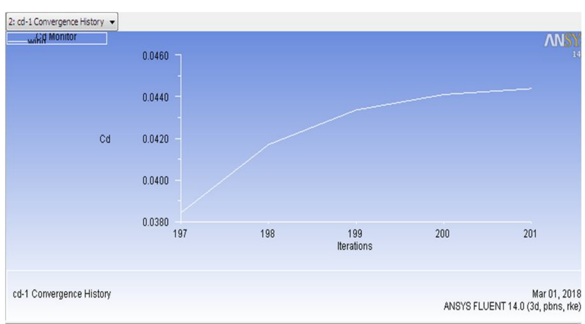
IV. ANALYSIS

A. Swept Wing With Scimitar Winglet

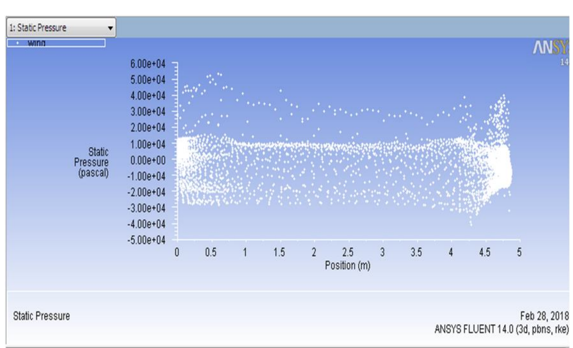
1) Pressure variation



2) Coefficient of drag vs position

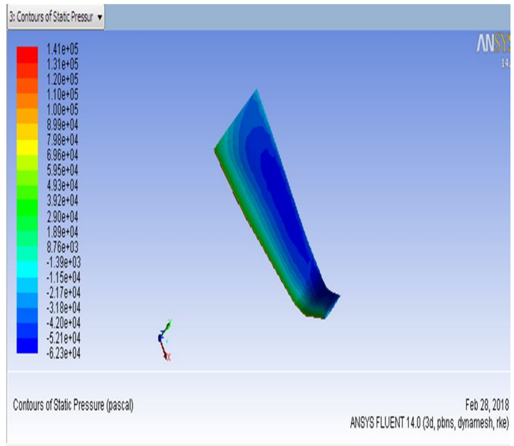


3) Scatter diagram

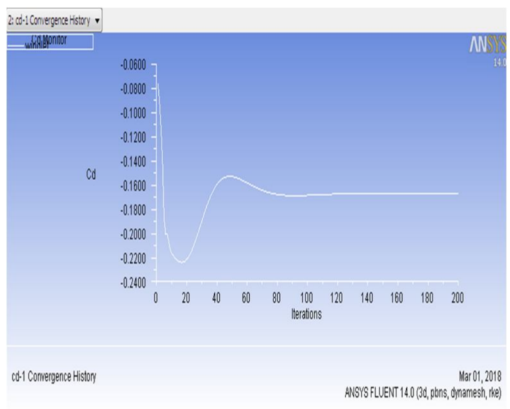


B. Staight Wing With Blended Winglet

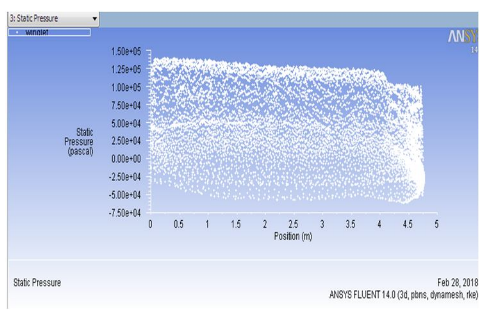
1) Pressure contour plot



2) Coefficient of drag vs itrations

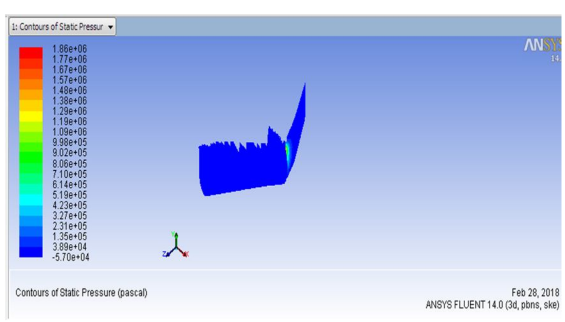


3) Scatter diagram

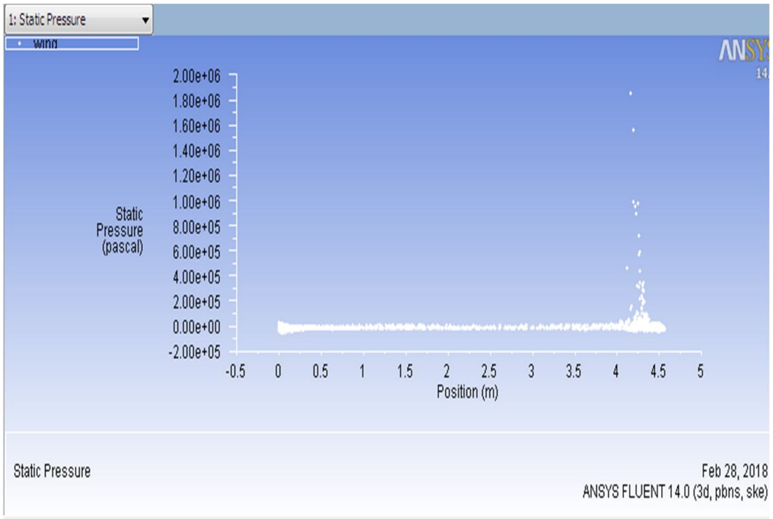


C. Straight Wing With Scimitar

1) Pressure variation

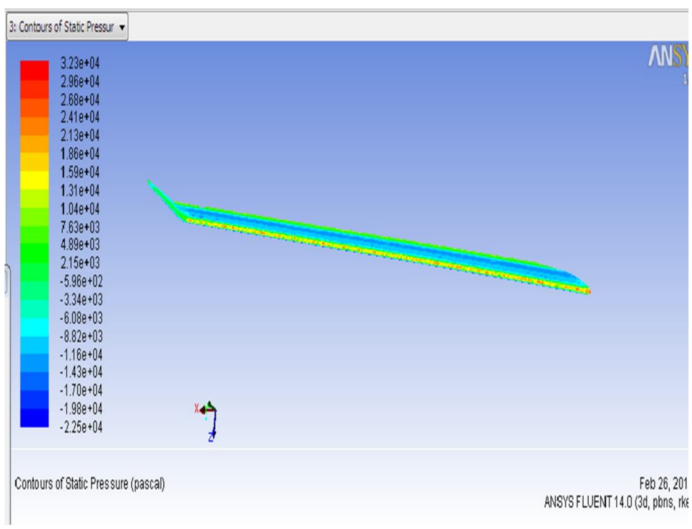


2) *Scatter diagram*

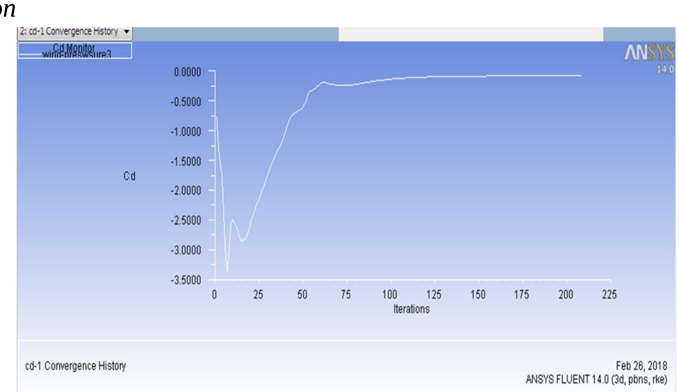


D. *Swept Wing With Blended Winglet*

1) *Pressure variation*



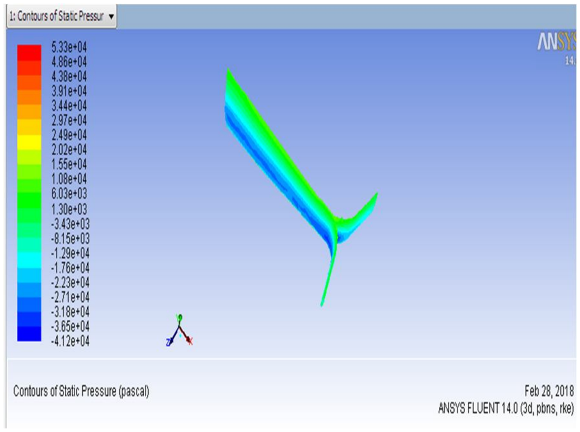
2) *Co efficient of drag vs position*



V. COMPARISON OF RESULT

A. On comparison of four design the coefficient of drag value for swept scimitar is more efficient than other designs.

B. The value of co efficient of drag 0.004



C. While analyzing the straight wing with scimitar found that pressure is very low which is affecting induced drag.

D. Sweptback wing with blended winglet analysis showing the gradually pressure variation over the body.

E. Straight wing with blended winglet analysis found that low pressure applying upper part of the body and high pressure on the lower part of it.

VI. APPLICATION

A. Blended Winglet

1) The blended winglet can increase the fuel mileage up to 6-8%.

2) The cruise thrust levels are reduced as 3-4%.

3) Winglets are also applied to other business aircraft.

4) Its designed to increase payload-range on hot and high retrofit.

B. Scimitter Winglet

1) Additional fuel burnt saving over the blended winglet.

2) It provides the perfectly balanced winglet that maximize the overall efficiency of the wing.

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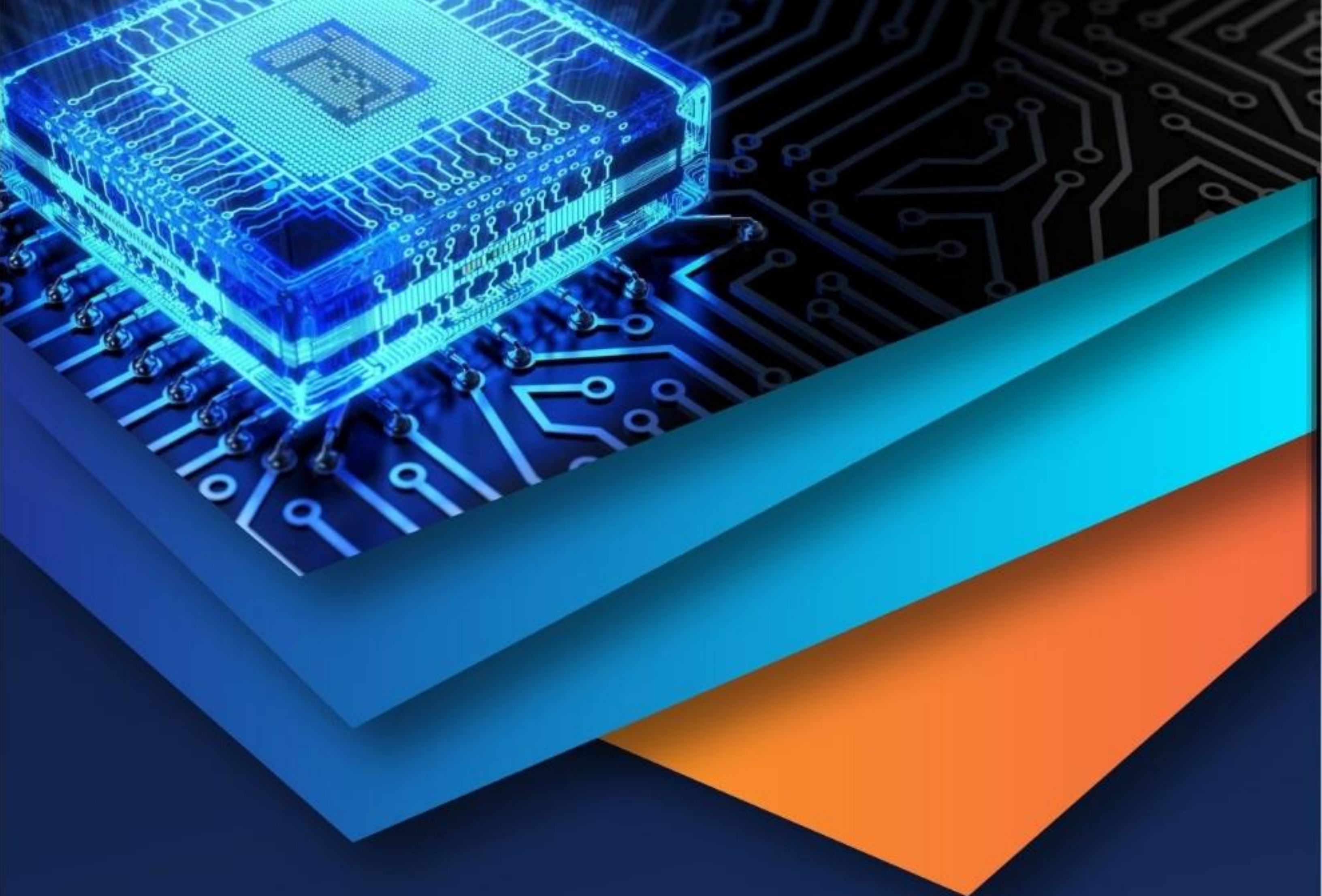

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