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FEA: CFD Analysis of Quad Copter Drone

Akanksha Vaibhavkumar Narule

Department of Mechanical Engineering, Vishwakarma Institute of Information Technology, Maharashtra, India

Abstract **- Finite element analysis is the process of simulating and analyzing behavior of the parts and assembly under prerequisite conditions. FEA usually used to simulate physical phenomenon as well to reduce the need of physical prototype. Computational fluid dynamics is sub branch of fluid dynamics as it a science that, with the help of computers, CFD produces quantitative predictions of fluid flow in the system. In this research work CFD analysis of quad copter is presented, focusing on aerodynamic characteristics optimization. Quad copter is unmanned aerial vehicle i.e UAV that its configuration is relative to program for autonomous flight that allows experiment with complex swarming behavior. The objective of the research is to analyze the design of quad copter as of weather design specification meets the desired outcomes. Design of geometry is done in ansys space claim modeler as well as Effects of loads and different boundary conditions were done on quad copter using ANSYS software.**

Keywords: Finite Element Analysis, Computational fluid dynamics, Quad copter drone, Ansys software.

I. INTRODUCTION

A quadcopter is an aircraft designed by four horizontal rotors, each rotor consist of one or two blades. Quad copters are classified as rotor drone that distinguish between them from fixed blade aircraft because the quadcopter that derives its source derives source of lift from the rotor blades rotating around a fixed pin point.

The very first attempt of quadcopter the unmanned aerial vehicle as per records occurred in 1849 by besieging Venice. Austrian forces besieging Venice attempted to float quadcopter with incendiary balloons along with bomb as this quadcopter was used for the purpose of war.

The experimental attempts of taking off with a rotor-craft were done with multirotor drone on1907 Jacques and Louis Breguet, French brothers, built and tested Gyroplane No 1, a quadcopter. Despite of unstable design they managed take off with impractical analysis.

Quad copter drone has been in development since World War 1, the Curtiss N2C-2 quadopter drone was developed in 1937 by USA navy as the first radio-controlled airplane. The first large-scale produced drone to be used in military purposes in 1941, named Radio plane OQ-2 and developed by Reginald Denny.

In 1924 French engineer Étienne Oehmichen flew his quadcopter at a distance of 360m (1,181ft) setting a world record. In the same year he flew a 1km (0.62miles) circle in 7m and 40s. Around the same time George de Bothezat built and tested his quadcopter for the US army.

Initially UAV's were majorly used as equipment of military technology and was not that much widespread in civilian usage. With advancement in technology as of discovery of microcontrollers, micro computers, Rules for flying hobbyist's and so on drone became more common and as of all this parameters its has been used as civilian economical low budget physical project. It is used for simulation purpose as it was logically accessible.

II. SPECIFICATIONS

Boundary Conditions Are

Fluid	**air**
Solid	**aluminum**
Area	1 m^2
Density	1.225 kg/m^3
Enthalpy	0 J/kg
Length	1 mm
Pressure	0 Pa
Temperature	288.16 K
Velocity	1 m/s
Viscosity	1.7894e-05 kg/(m s)
Ratio of Specific Heats	1.4
Yplus for Heat Tran. Coef.	300
Reference Zone	fan_1

III. DESIGN MODEL OF QUAD COPTER

In this design we have designed components such as frame stand, fan casing and fan blades with specific dimensions and assembled in proper position.

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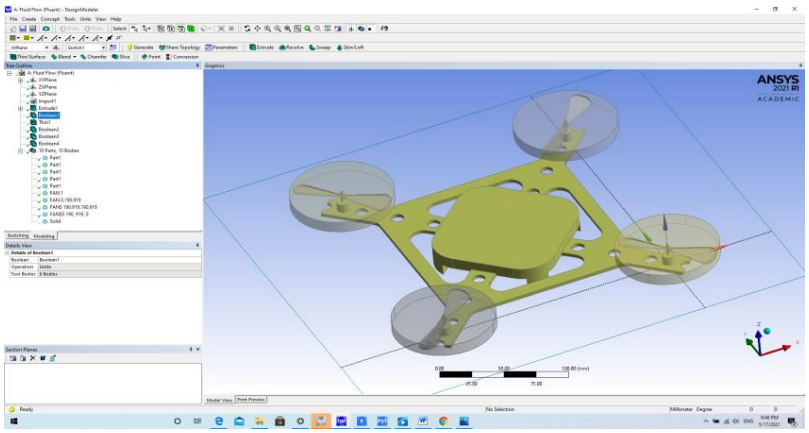
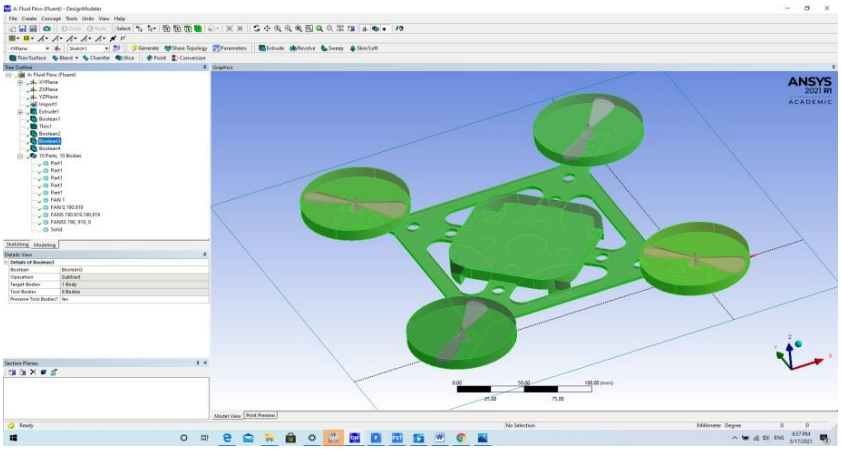


Initially we have done Boolean operation on assembled quadcopter. That is it helps in proper aligning of components.

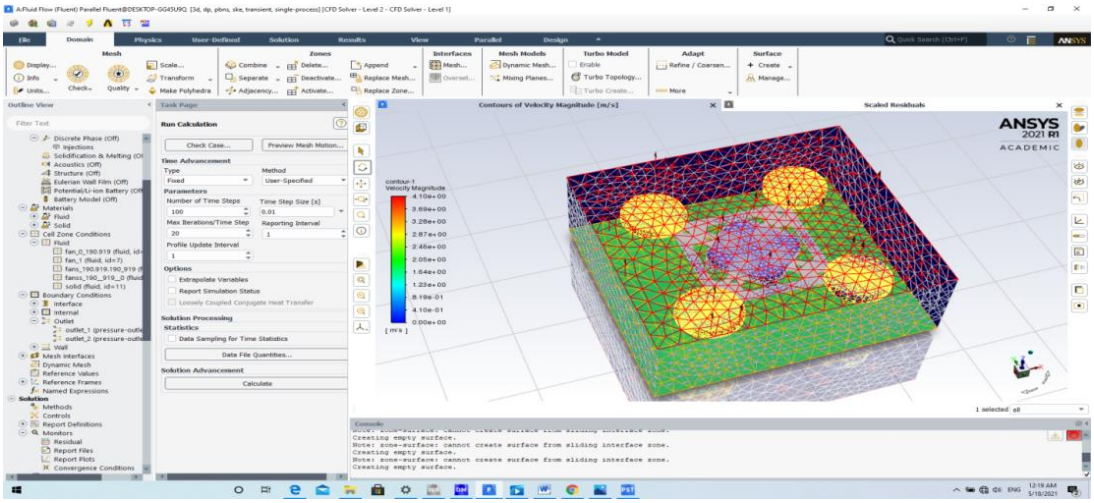


IV. MESHING OF MODEL

Here in meshing model we got cell, nodes and faces with fine meshing.

Cells	Faces	Nodes
431381	919926	82705

Modeling view is as –



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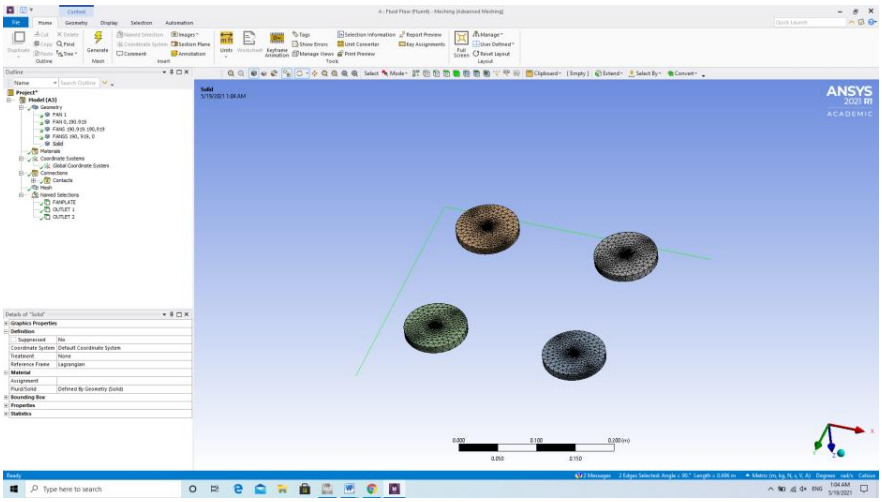
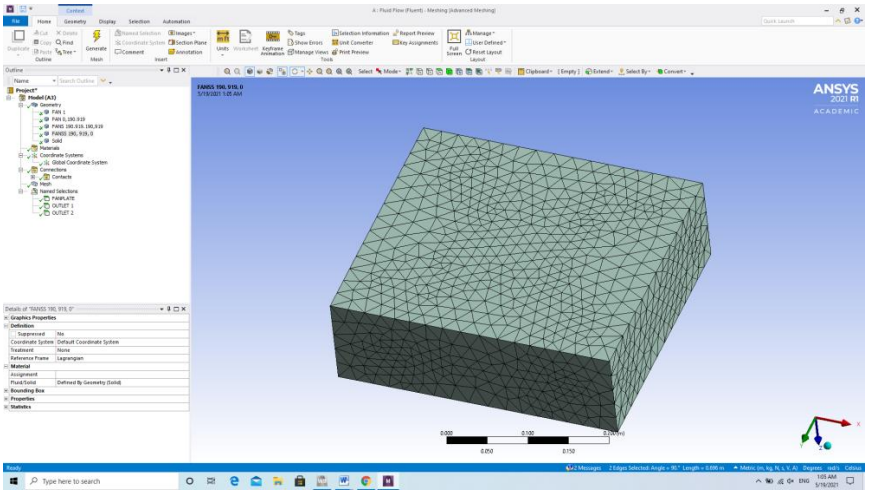
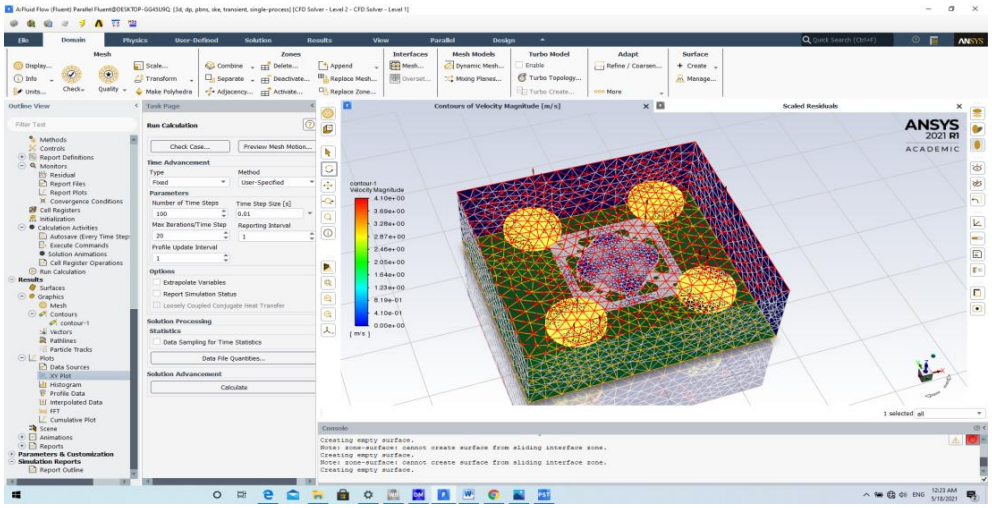
Meshing modeling view of fan:



Meshing view:



V. SURFACE MESH



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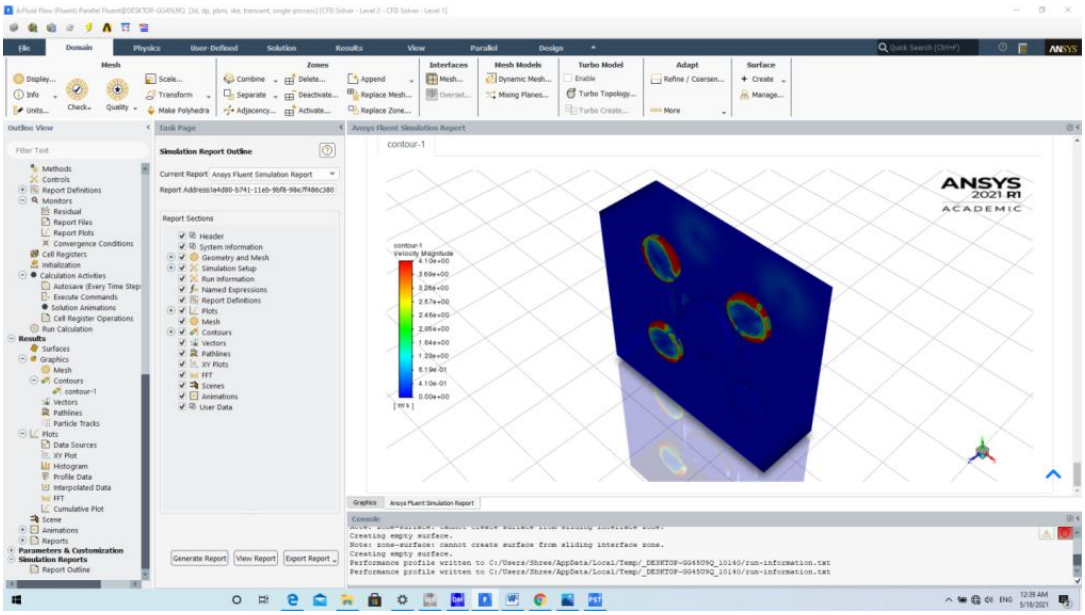
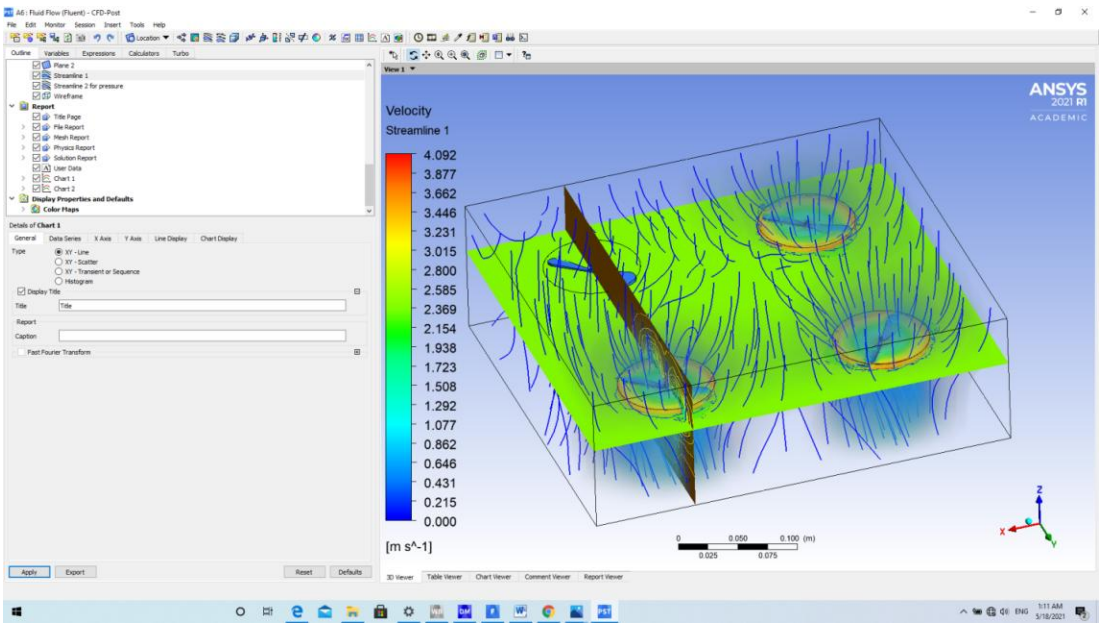
FLUID FLOW (FLUENT) MODEL

In fluent, parameters such as velocity magnitude, pressure, and number of steps have been calculated.



CFD POST ANALYSIS

Application of pressure and velocity counter, streamline flow is shown with sliced box along its XY axis and YZ axis respectively.



VI. RESULTS OF GRAPHS

1. Residuals Vs Iteration graph is as below:

Here number of steps plotted is 100 iterations.

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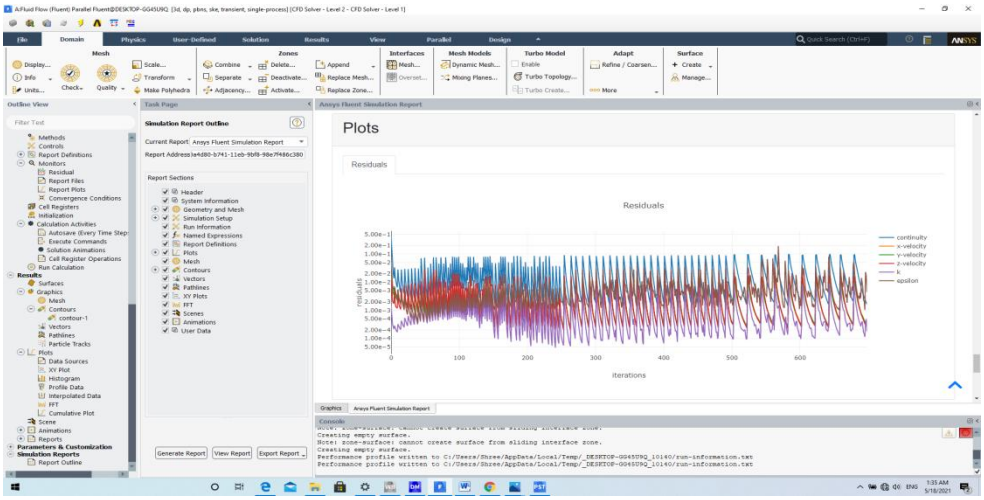
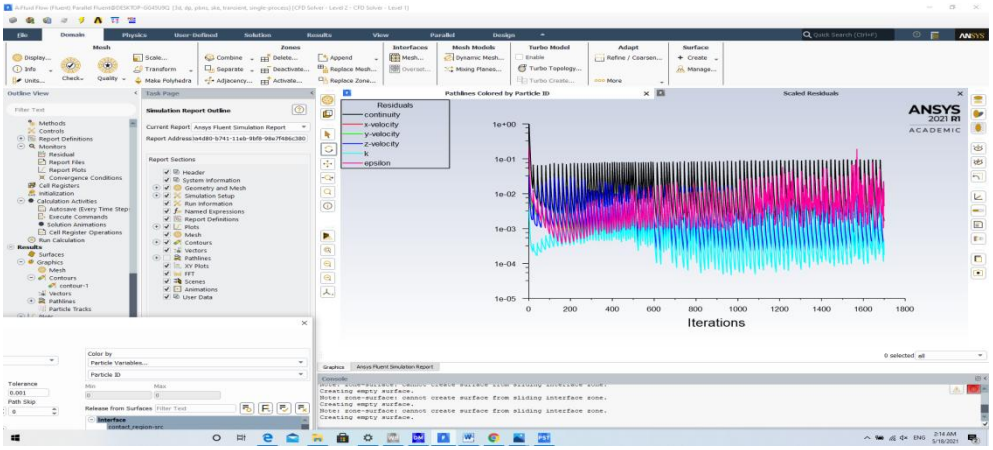


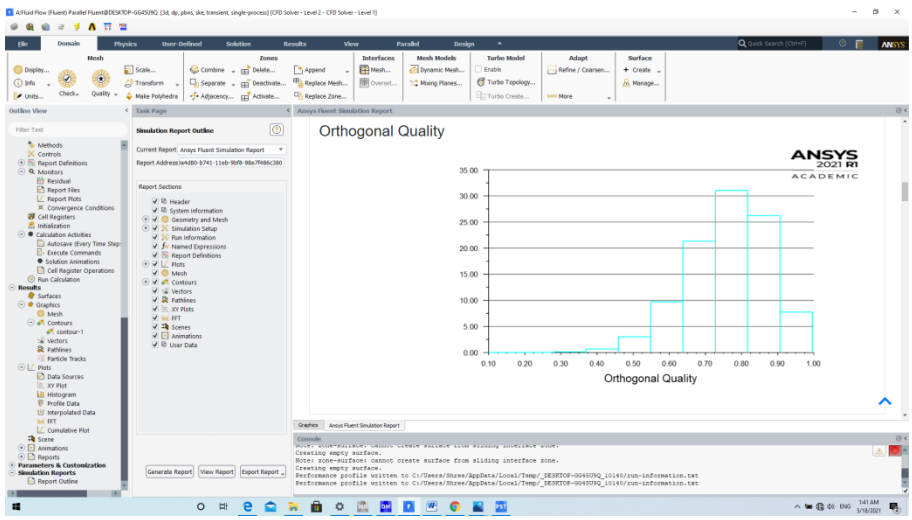
PATHLINE FLOW GRAPH

This graphs allows us a clear view of motion in quadcopter



MESH QUALITY

Graph shows orthogonal quality of mesh.



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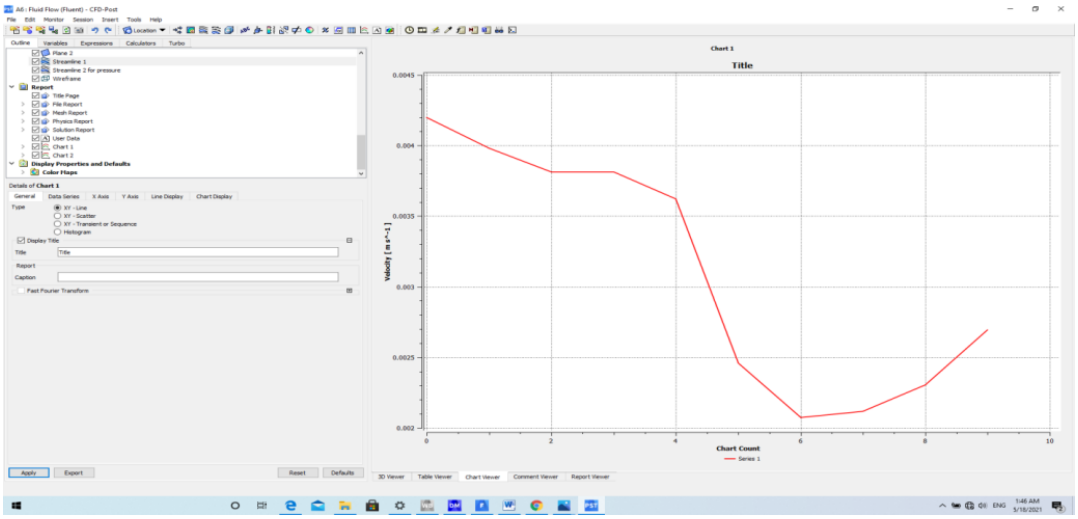
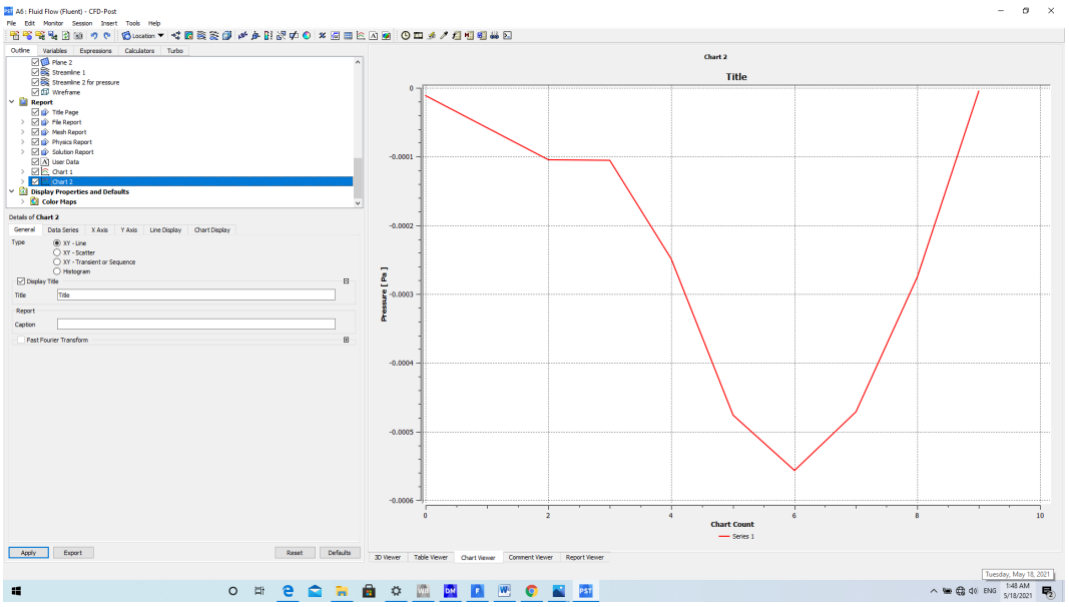
VELOCITY ITERATION GRAPH

Velocity Iteration analysis is done on post study analysis workbench.



PRESSURE ITERATION GRAPH

Pressure Iteration analysis is done on post study analysis workbench.



VII. RESULT AND DISCUSSION

Computational fluid dynamics has been done on ANSYS FLUENT. The parameters are given below which were used in finding out weather the model is perfect to simulate and work under certain load conditions.

Here number of steps plotted is 100 iterations.

delta-time	0.01 s
iters-per-timestep	20
flow-time	1 s

VIII. CONCLUSION

Above observation gives an idea about the design and analysis of a Quad-Copter Drone, hence the FEA analysis and CFD analysis of assembly has been done and is proved as safe since no deformation exceeds the given safety values. Design of Quad-Copter has explained various aspects and parameters of analysis using ANSYS workbench software; this result will help in better optimization of the Quad copter in future.

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REFERENCES

[1] The Dawn of the Drone" Steve Mills 2019 Casemate Publishers.
[2] Professor A. M. Low FLIGHT, 3 October, 1952 page 436 "The First Guided Missile
[3] Donald, David, ed. Encyclopedia of World Aircraft (Etobicoke, Ontario: Prospero Books, 1997), p.854, "Standard aircraft"
[4] Taylor, John W. R.. Jane's Pocket Book of Remotely Piloted Vehicles.
[5] Design Methodology For Unmanned Aerial Vehicl (UAV) Team Coordination By F.B. Da Silva, S.D. Scott, And M.L. Cummings.
[6] G.M. Hoffmann, H. Huang, S. L. Waslander and C J Tomlin, "Quad rotor helicopter flight dynamics and control: Theory and experiment", Proceeding of the AIAA Guidance, Navigation and Control Conference and Exhibit, Aug. 2007.

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