AE361A Aeromodel Design and Fabrication

CONTENT:

Acknowledgement

We would like to extend deepest gratitude to everyone who contributed to the successful creation of this model RC airplane. Firstly, we are especially thankful to Abhijit Kushari Sir, whose guidance and expertise were invaluable throughout the design and construction process.

A special thank you goes to Hariom Bajpai Sir, for their support and assistance. Whether it was brainstorming solutions to mechanical issues or just offering words of encouragement, your support was crucial to keeping the project on track. Your patience and detailed feedback were instrumental in overcoming the challenges faced during the development of this model.

We are also grateful to IIT Kanpur, whose resources and facilities provided the ideal environment for both building and testing the plane. The assistance provided by the staff and members of the lab was incredibly generous and appreciated.

Cessna 150

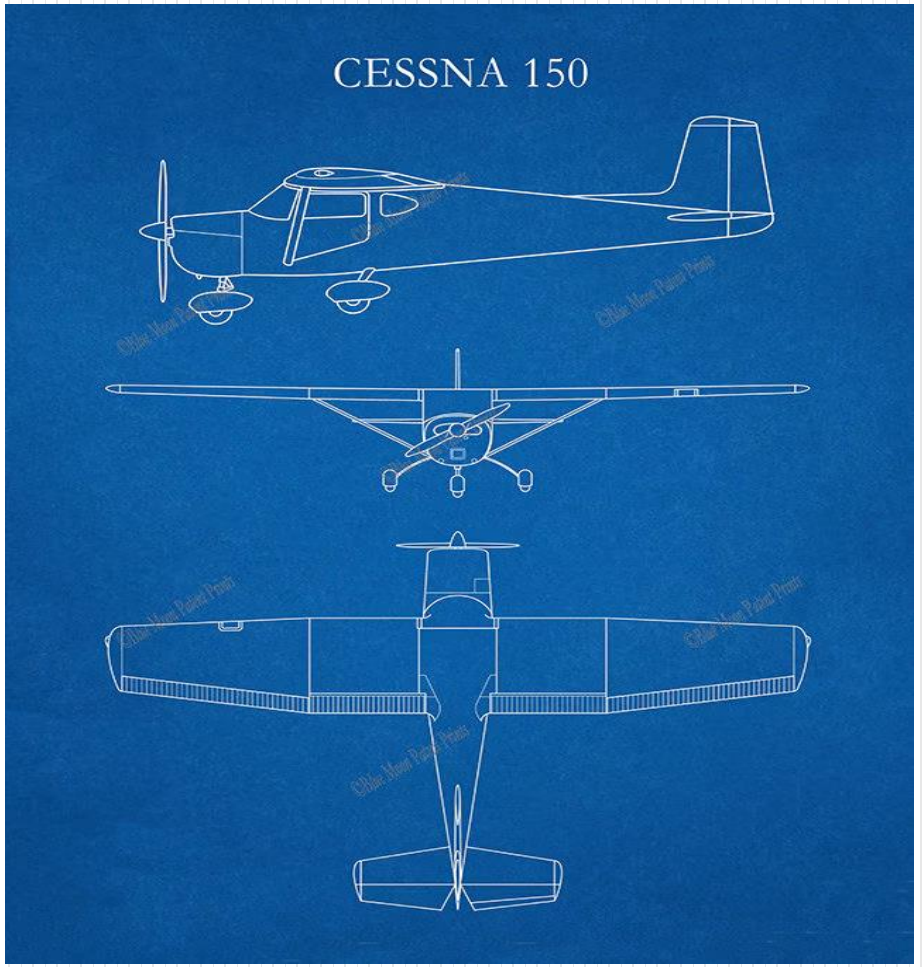
The Cessna 150 is a quintessential part of aviation history, renowned for its role as a premier trainer and personal aircraft. Introduced in 1958 by the Cessna Aircraft Company, the Cessna 150 is a two-seat, single-engine, tricycle gear airplane that quickly became one of the world's most popular light aircraft. Over its nearly two decades of production, which ended in 1977, more than 23,000 units were manufactured, cementing its role in training generations of pilots.

With its straightforward design, reliable performance, and forgiving flight characteristics, the Cessna 150 has been a staple in flight schools around the globe. The aircraft's lightweight construction and efficient performance made it ideal for beginners and recreational flyers alike, offering a manageable yet thorough introduction to piloting. Its simple yet robust construction ensures durability and ease of maintenance, factors that have contributed to its lasting popularity in the general aviation community.

The Cessna 150's legacy continues as it remains a popular choice for flight training, recreational flying, and is often a first aircraft for many private owners, embodying the spirit of aviation with every flight.

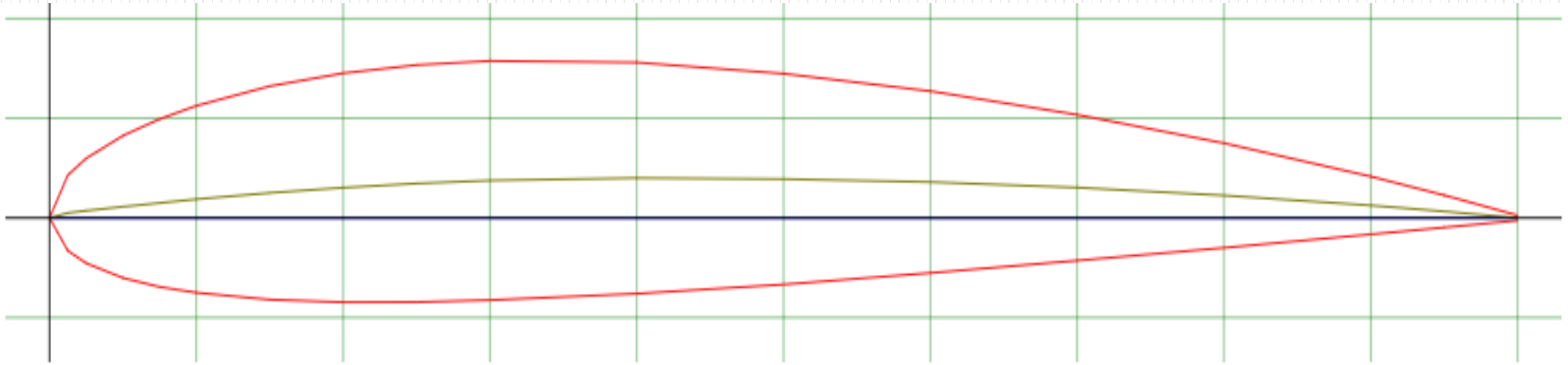
Blue print of Cessna 150

- Single prop front Mounted
- Fixed wing
- High wing configuration
- Inverted ‘T’ empennage



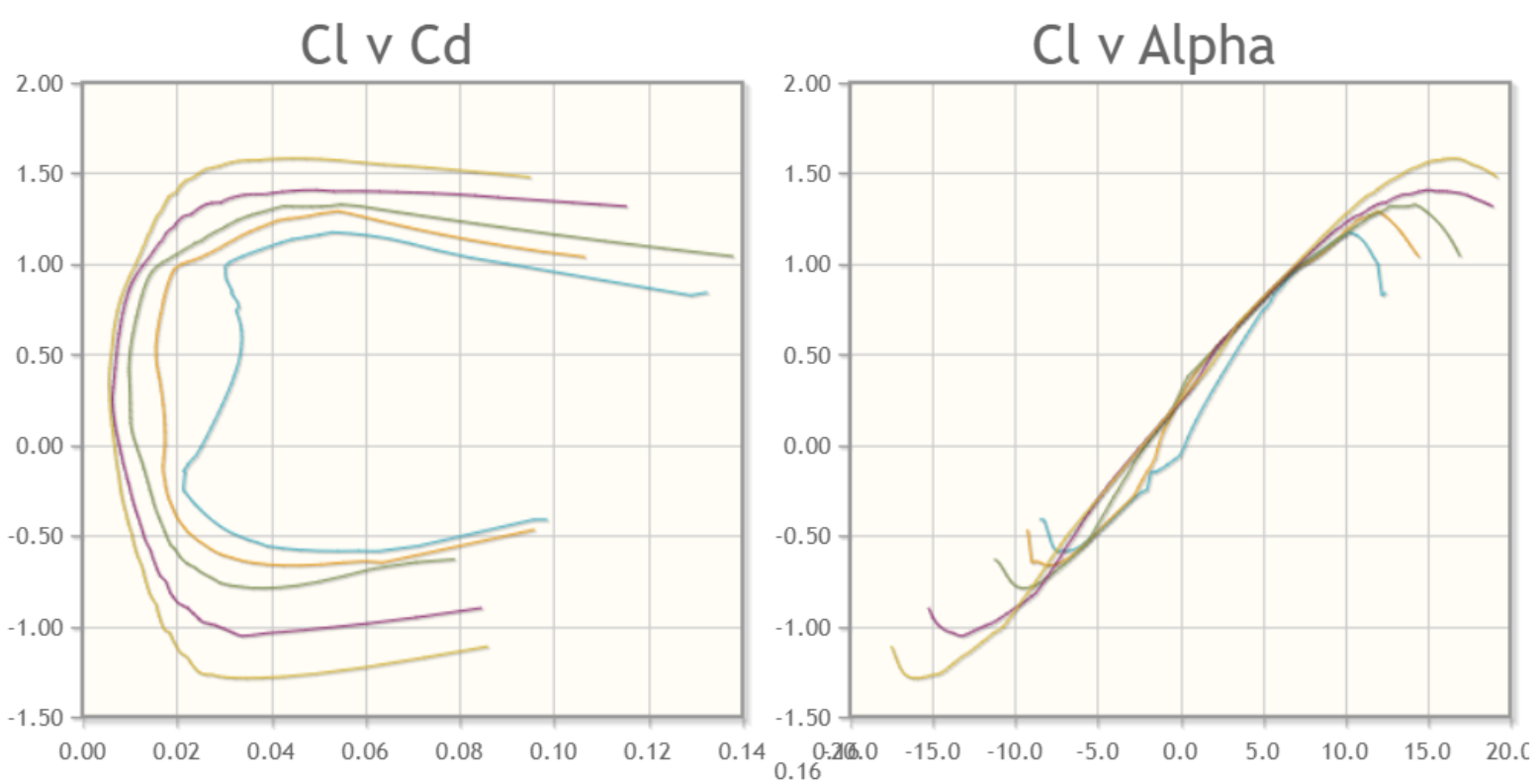
Airfoil Specs

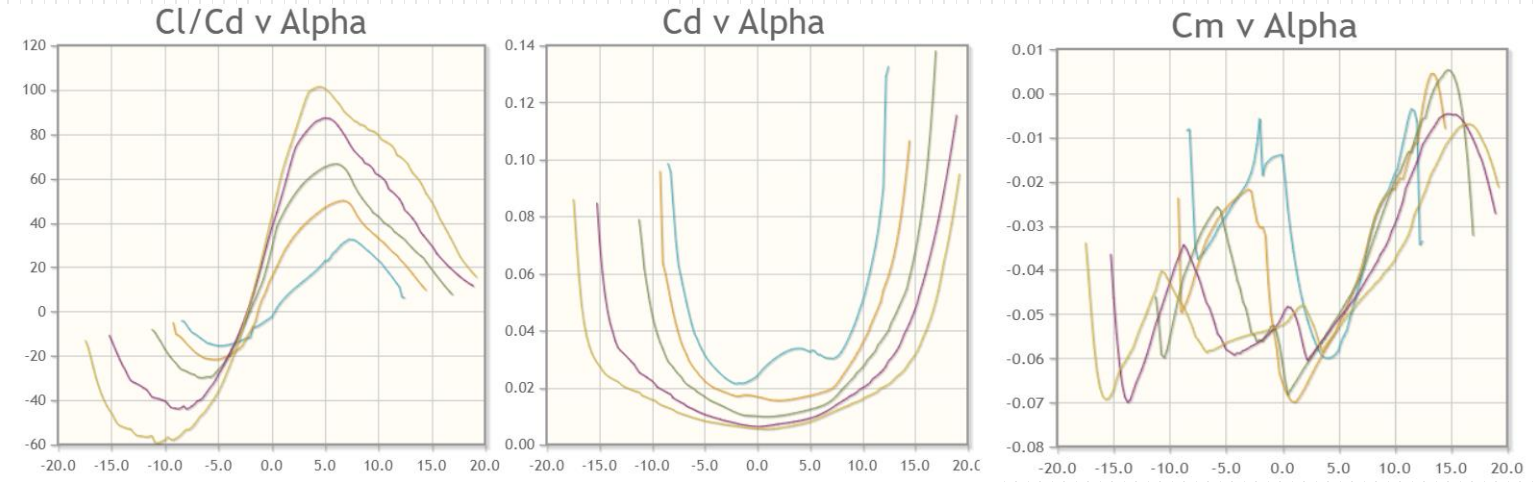
- NACA 2412



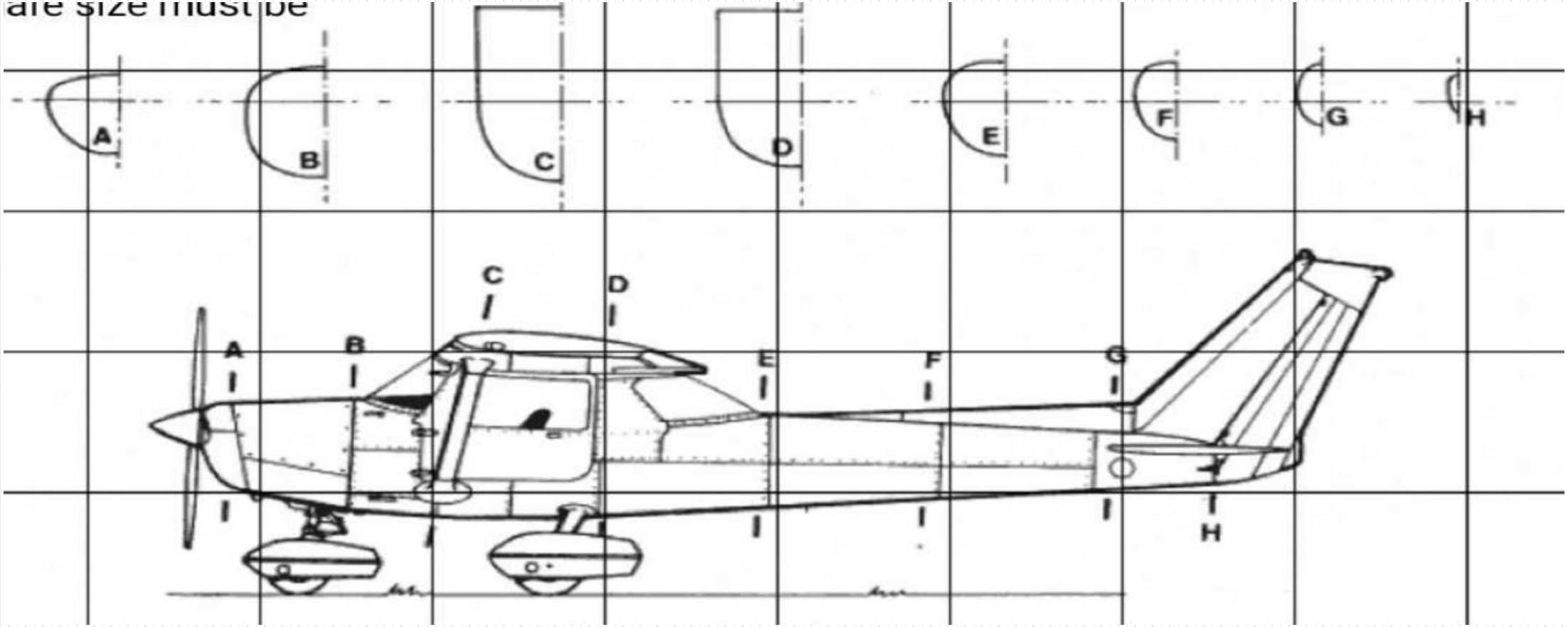
Details

(naca2412-il) NACA 2412
NACA 2412 airfoil
Max thickness 12% at 30% chord.
Max camber 2% at 40% chord
Source UIUC Airfoil Coordinates Database
Source dat file
The dat file is in Selig format


Cl v Cd
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
0.00 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16
Cl v Alpha
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-15.0 -10.0 -5.0 0.0 5.0 10.0 15.0 20.0


Cl/Cd v Alpha
120
100
80
60
40
20
0
-20
-40
-60
-20.0 -15.0 -10.0 -5.0 0.0 5.0 10.0 15.0 20.0
Cd v Alpha
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
-20.0 -15.0 -10.0 -5.0 0.0 5.0 10.0 15.0 20.0
Cm v Alpha
0.01
0.00
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-20.0 -15.0 -10.0 -5.0 0.0 5.0 10.0 15.0 20.0

Fuselage:



Component selection

- Foam board for the airframe
- Foam board (30mm thick) for the wing and tail surfaces
- Small motors, servos
- Radio control system
- Glue, wire, and other small hardware for assembly
- Sandpaper, paint, and other finishing materials

FINALIZED DIMENSIONS:

- Fuselage :
  Length - 73cm
  Width- 14cm
- Horizontal stabilizer:
  Length - 42.5cm
  Width– 9cm
- Elevator:
  Length - 5.2cm
  Width– 3cm
  Thickness- 1cm
  (as we move from left to right)

- Wing:
  Span - 127cm
  Max Thickness - 2.2cm
  Rectangular part of wing
  Length - 53.5cm
  Chord – 23cm
  - Tapered part of wing
    Length - 36.5 cm
    Chord – 17cm
- Vertical stabilizer:
  Length - 20.7cm
  Thickness -1.3cm

FINALIZED DIMENSIONS:

- Landing gear:

  (2+1=3 wheels used)

  Height of Front 2 wheels :- 9cm

  Height of back wheel :- 7cm
- Rudder:

  Length :- 18.5cm

  Width :- 5cm
- Aileron :

  Length :- 25cm

  Width :- 4.6cm

Electronic specification:

- Battery- 2200mAh 3S 30C/60C (LiPo)
- Motor - DYS 1400kv BLDC Motor
- ServoX4 - (2x Aileron, 2x elevator)
- ESC - 30A ESC
- Receiver - FlySky 10 channel
- Type of Engine- Brushless DC Motor

Estimated Weight

- Total Weight :- 889 g
- Battery Weight :- 178g
- BLDC Motor (1400kV) Weight :- 53g
- Body weight :- 550gm approx.

❖ We are using 1400 kV motor and a 9 * 3.8 E propeller for our model.

Calculations

- Aerodynamic center $= \frac{c}{4} = \frac{23}{4} = 5.75$cm from LE of wing
- Center of Gravity = 5.7cm from LE of wing
- 3D lift coefficient slope, with angle of attack depends on 2D lift coefficient slope:

$$C_{L_\alpha} = \frac{C_{l_\alpha}}{1 + \frac{C_{l_\alpha}}{\pi e (AR)}}$$

- $C_{L_0} = 0.3$
- $C_{D_0} = 0.01$
- $C_{l_\alpha} = 6.88$
- $C_{L_\alpha} = 5.093$
- $C_L = 0.3 + 5.093\ \alpha$

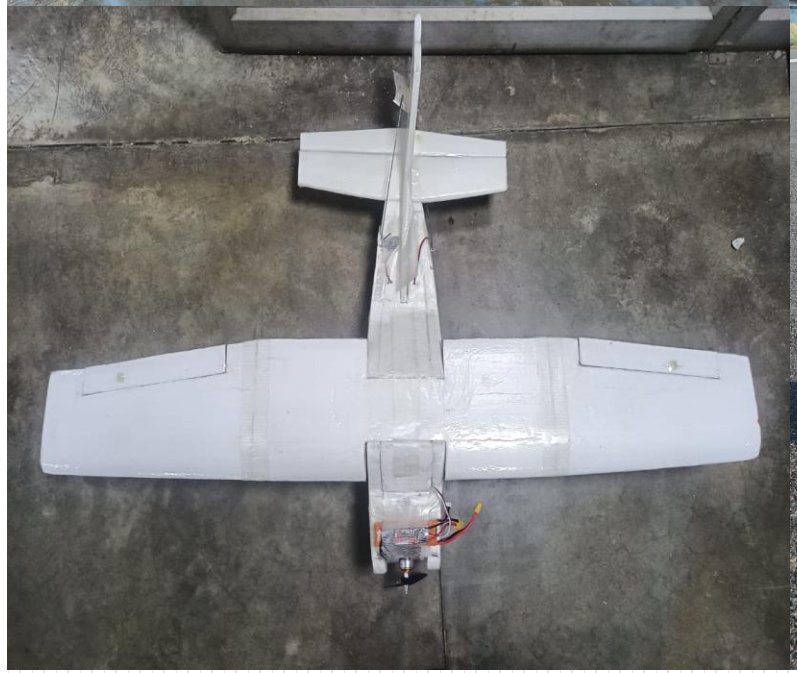
Calculations

- When fuselage reference line is horizontal, the wing AOA was 5 deg.
- $C_{L_5} = 0.74$
- $C_D = C_{D_0} + \frac{C_L^2}{\pi e(AR)}$
- $C_D = 0.038$
- Lift, $L = W = 0.889 * 9.81 = 8.721\ N$
- As, $L = \frac{1}{2}\rho V^2 S C_L \implies 8.72 = \frac{1}{2}\rho V^2 S C_L$

  $\implies V = 9.15\ m/s$

- And Drag, $D = \frac{1}{2}\rho V^2 S C_D = 0.45\ N$

Fabrication of Model:



Estimated Cost

- Wing + Body =300
- Battery + Motor + Propeller= 2850+500+150=3500
- Control and Communications= 6000+500+2400=8900

- Total Cost =12700 Rs.

Test Fly

Conclusion

- In conclusion, our experience building and flying the RC plane using thermocol in this lab course was rewarding. We applied concepts from basic courses like MOS, propulsion, and flight controls, which helped us understand the principles behind aircraft design. The successful flight demonstrated the importance of attention to detail and teamwork. These experiences have equipped us with valuable skills and a deeper understanding of aerospace engineering, inspiring us for future projects in the field.