AE 244: Assignment 3

Weightage: 15% of the total grades

Deadline: 6th April 2024 (Sunday) 11:59 PM
(Submissions after this deadline will attract 5% penalty for each 30 minutes delay. For example, 15% will be deducted from the assignment grades if the submission happens at 1:30 AM)

A note on plagiarism:

This is an individual assignment. While discussion is encouraged, simply copying someone else's work will attract zero marks for all involved.

Overall Background

You wish to participate in the Short Take-Off and Landing Aircraft Competition and being an aerospace engineer, you have decided to design an aircraft to compete completely by yourself. You already have a Lycoming O-320 engine with you, which you plan on using in your aircraft. Considering that you are the one who is also going to pilot the aircraft, your aircraft is capable of carrying you considering your height and weight.

Goal for Assignment 3:

Now that we have a fair idea about the aerodynamic forces and flows around airfoil and tools used in predicting the same, we can proceed with the task of designing the complete STOL aircraft comprising of wings, fuselage, and stabilizers.

The requirements from the STOL aircraft to be designed are:

1. Should sit one person (you)
2. Should not take more than 200 m to take-off.

Tasks

1. Learn OpenVSP for aerodynamic simulations
2. Create a tool (MS Excel or computer program) to estimate approximate overall weight of the aircraft based on the dimensions of the aircraft's parts and material used.
3. Wing design and analysis
    a. Design the wing (considering the lifting requirements)
    b. Analyse the performance of the wings (lift, drag) at a range of angles of attack using lifting line theory for lift and induced drag estimates.
    c. Use the empirical method to estimate the parasite drag.

   d. Compare the final results with those obtained through OpenVSP.
   e. Plot and compare airfoil and wing lift coefficient curves.
4. Fuselage design and analysis:
   a. Create a CAD model of the fuselage that meets requirements.
   b. Estimate lift and drag of the fuselage using OpenVSP.
   c. Compare the fuselage drag found through OpenVSP with that from the empirical method to estimate parasite drag.
   d. Comment on the observations.
5. Stabilizer design and analysis:
   a. Design horizontal and vertical stabilizers for the aircraft
   b. Analyse performance of the stabilizers using OpenVSP for various angles of attack.
6. Overall aircraft design and aerodynamic analysis
   a. "Assemble" the aircraft components into a complete aircraft.
   b. Estimate performance of the entire aircraft using Open VSP (C_L & C_D vs α)
7. Validate requirements
   a. Check if the designed aircraft meets the original operational requirements.
   b. Comment on the outcome of the design process.

Report Structure

1. Wing Design

1.1. Full description of wing designed (airfoil, taper, angle of attack, twist, sweep, dihedral, other devices and attachments if any), <u>with rationale</u> behind each the design decision [6]

1.2. C_L vs α curves of the wing for α = -3° to 12° in increments of 3° computed using the lifting line theory and OpenVSP (in the same plot). [12]

1.3. C_D vs α curves of the wing for α = -3° to 12° in increments of 3° computed using the classical method (induced drag + empirical parasitic drag) and OpenVSP (in the same plot) [12]

1.4. C_L vs α of the wing and C_l vs α of the constituent airfoil for α = -3° to 12° in increments of 3^0 as computed using OpenVSP on the same plot [3]

1.5. Main observations and interpretations from sections 1.2, 1.3, and 1.4. [3]

2. Fuselage Design

2.1. CAD of the fuselage, mentioning aspects considered for design [5]

2.2. Lift and drag estimates from OpenVSP at α = -3° to 12° in increments of 3° [6]

2.3. Parasitic drag estimates based on empirical method (at α = 0°) [5]

2.4. Comparison of drag results from 2.2 and 2.3, and comments [3]

3. Stabilizer Design

3.1. Horizontal and Vertical stabilizer designs (dimensions, airfoil, sketch/CAD) with rationale behind the design [5]

3.2. C_L vs α curves for both stabilizers for α = -3° to 3° in 1° increments using OpenVSP [5]

3.3. C_D vs α curves for both stabilizers for α = -3° to 3° in 1° increments using OpenVSP [5]

3.4. Comments on findings from 3.2, 3,3. [3]

4. Overall aircraft design

4.1. Overall aircraft design (placement of wing, stabilizers, fuselage, pilot) and CAD, with rationale [8]

4.2. Aerodynamic performance of the entire aircraft using Open VSP (C_L & C_D vs α) [5]

4.3. Aircraft component weight estimates (using CAD) and total weight [4]

5. Design Validation

5.1. Takeoff speed, takeoff distance, maximum speed, speed for maximum endurance [6]

5.2. Comment on aircraft performance w.r.t original requirement and possible scope for improvements [4]

6. Acknowledgement

Mandatory to acknowledge people you discussed with or took help for any part of the assignment.

7. References

List all references (books, paper, websites, etc.) used while doing the assignment