Sizing Report

Course: MAE 159 - Aircraft Performance

Advisor: Prof. Robert Liebeck

T.A. Seraphin Yeung

Author: Triet Ho

Winter 2025 specifications:

Number of passengers (2-class, domestic rules)	210
Weight of cargo (10 pounds/ft^3) Maximum Payload Weight 55,000 lbs	8000 pounds
Range (still air)	3500 nautical miles
Takeoff field length (sea-level, hot day 84º f)	6900 feet
Landing approach speed	135 knots
Cruise Mach number	0.80
Initial cruise altitude	35,000 feet
Maximum wingspan	125 feet
Maximum landing weight with 45% fuel	

Engine Configuration: 2 JT9D-class engines, wing-mounted

Seating Layout: 6 abreast

Wing Design: Taper ratio = 0.35

Date: February 5, 2025

Table of Contents

Nomenclature List

SYMBOL	DEFINITION

List of Figures

List of Tables

1. Introduction

In this study, a commercial transport aircraft is designed and optimized for economic performance. The designed aircraft has to satisfy both safety requirements and the operational specifications such as range, speed, cargo weight, etc. After meeting all the requirements, the aircraft is then optimized for the best economical performance. Specifically, this study aims to minimize the aircraft's Direct Operating Cost (DOC). In order to achieve the minimum DOC, wing aspect ratio (AR) and swept angle (Λ) are varied. Furthermore, advanced technology is applied and compared with the existing technology to get better DOC performance.

1.1 Design Specifications

Specification	Value
Number of Passengers	210 (2-class, domestic rules)
Cargo Weight	8,000 lbs (10 lbs/ft^3)
Maximum Payload Weight	55,000 lbs
Range (still air)	3,500 nautical miles
Takeoff Field Length	6,900 feet (sea-level, hot day 84°F)
Landing Approach Speed	135 knots
Cruise Mach Number	0.8
Initial Cruise Altitude	35,000 feet
Maximum Wingspan	125 feet
Maximum Percent Fuel Weight at Landing	45%

Table 1: Aircraft Design Specifications

Table 1 shows the specifications that the commercial transport aircraft is required to meet. These design parameters define the aircraft's operational capabilities, including passenger and cargo capacity, range, takeoff, landing performance, and aerodynamic constraints. These specifications serve as the foundation for the design analysis, guiding the selection of trial configurations and the evaluation of advanced technologies to improve performance and reduce direct operating costs.

Mode	Configuration	Velocity	Minimum Gradient
1st Takeoff Segment	Gear Extended Flaps in Takeoff Engine out	> 1.2 V_stall	0.00%
2nd Takeoff Segment	Gear Retracted Flaps in Takeoff Engine out	> 1.2 V_stall	2.40%
3rd Takeoff Segment	Gear Retracted Flaps Retracted Engine out	> 1.2 V_stall	1.20%
Approach	Gear Retracted Flaps in Takeoff Engine out	> 1.3 V_stall	2.10%
Landing	Gear Extended Flaps in Landing All Engine	> 1.3 V_stall	3.20%

Table 2: Safety Requirements for 2-Engines Aircraft

Besides the explicit design specifications in Table 1, the aircraft also has to meet the safety requirements in Table 2. The Mode column describes what flighting phase the aircraft is in. The first three rows belong to the climb gradient section. In this section, aircraft velocity has to be greater than 1.2 the stall velocity and minimum gradient ensure that there's enough clearance for the aircraft to take off without infrastructure interference. Similarly, in approach and landing phase, the aircraft has to travel at greater than 1.3 the stall velocity and the minimum gradients ensure departure clearance and also space for correcting if there's engine failure.

1.2 Goals of the study

The final objective of this study is to find the design that satisfies all the requirements and has the lowest DOC. This is achieved by iterating aircraft design parameters and applying advanced technology. Therefore, three smaller objectives can be laid out as:

1. **Optimizing Aircraft Design Parameter:** Find the wing aspect ratio (AR) and swept angle (Λ) combination that gives the lowest DOC.

2. **Comparing Conventional and Advanced Technology Designs:** Applying advanced technology to the aircraft design and comparing it with the conventional technology.
3. **Selecting an Optimal Final Design:** A final design will be selected that gives the best economic performance while meeting the design requirements.

2. Design Analysis

The design process involves multiple phases including the initialization of the code, accuracy validation via hand calculations, and finally iterations for optimization. This report serves as the analysis for the data generated from the final code.

2.1 Basis for selection of trial designs and parameter variations

Blah blah blah

2.2 DOC versus performance

Blah blah blah

2.3 Basis for selection of the final design(s)

Blah blah blah

2.4 Specifications of the final design(s)

Blah blah blah

3. Conclusions

Blah blah blah

4. Acknowledgments

I want to thank T.A. Seraphin Yeung and Prof. Robert Liebeck for teaching and lecturing about the necessary theory in order to grasp the purpose and scope of this study.

5. References

[1]
[2]
[3]
[4]

6. Appendices:

Look for Appendix Assignments for MATLAB code and Hand Calculations