

# CEE 5614: Analysis of Air Transportation Systems Spring 2026

## Assignment 4: Air Transportation Systems Analysis

Due: February 24, 2026

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### Problem 1

Use the new generation, long-range, twin-engine aircraft (similar to the Boeing 787-8 Dreamliner) file to answer this question ([http://128.173.204.63/cee5614/cee5614\\_pub/B787\\_class.m](http://128.173.204.63/cee5614/cee5614_pub/B787_class.m)).

- Estimate the **aircraft rate of climb** after departing Phoenix International Airport (PHX) as the aircraft flies at an altitude of 5,000 feet mean sea level with an indicated airspeed of 250 knots. Assume the aircraft mass at 5,000 feet is 195,000 kilograms. Assume ISA conditions.
- Repeat the rate of climb calculation at 15,000 feet (280 knots indicated airspeed), and 30,000 feet while climbing at Mach 0.75. Assume the aircraft mass at 15,000 feet is 193,000 kilograms and at 30,000 feet is 190,000 kilograms. Assume ISA conditions in both scenarios.
- Repeat part(a) if the aircraft suffers an engine failure while climbing at 5,000 feet and 250 knots indicated airspeed.
- Compare the rates of climb obtained in parts (a-c). Comment on the implications of an engine out condition at 5,000 feet in altitude for the aircraft.
- Use the Unrestricted climb rate Matlab script to estimate the time to climb to 30,000 feet after departing an airport at sea level conditions with a takeoff weight of 210,000 kilograms. Use the climb profile provided in the Matlab file ([http://128.173.204.63/cee5614/cee5614\\_pub/B787\\_class.m](http://128.173.204.63/cee5614/cee5614_pub/B787_class.m)).
- Repeat part (e) if the departure weight is 260,000 kilograms. Estimate the differences in climb distance and time to reach 30,000 feet.

### Problem 2

Use the Boeing 787-class file ([http://128.173.204.63/cee5614/cee5614\\_pub/B787\\_class.m](http://128.173.204.63/cee5614/cee5614_pub/B787_class.m)) to answer the following questions

- Estimate the value of Specific Air Range (SAR) for the aircraft while in cruise at Mach 0.80 and 37,000 feet. The aircraft mass is 205,000 kilograms.
- Repeat the process in part(a) after a long flight if the mass is now 165,000 kgs. Comment on the effect of aircraft mass on the value of SAR.
- Use the Breguet Range equation, to estimate the maximum range for the aircraft if the aircraft reaches the TOC point (35,000 feet) at 204,000 kilograms. The aircraft cruises at Mach 0.80. The pilot estimates the aircraft carries 65,000 kilograms of fuel remaining at the TOC point. In the range calculation, assume the range is calculated using the aircraft mass at the mid-point between TOC and TOD. Also, assume that 5,500 kilograms of fuel are needed in the descent plus a possible diversion to an alternate airport.
- Solve the problem in part (c) using a piecewise numerical analysis method (as explained class). Use the range value obtained in part (b) and refine the answer obtained by dividing the range into five segments in the numerical solution. Comment on the differences obtained in parts (c) and (d).

## Problem 3

Commercial Aviation is an industry that, for many years, has attempted to reduce its CO<sub>2</sub> emissions in order to reduce the impact in Climate Change. One idea to decarbonize aviation is to use electric vehicles. Read the paper entitled: "Operation and Performance Optimization of an All-Electric, Narrow-Body Airliner" by Sampson and Drake (<https://doi-org.ezproxy.lib.vt.edu/10.2514/6.2024-4185>).

- A) Explain if the findings of the study support the idea of introducing an all-electric aircraft similar to the Airbus A220-100 in the 2035-2040 timeframe.
- B) Explain what are the main drawbacks of an all-electric airliner.
- C) Comparing the payload-diagrams of the proposed all-electric aircraft and the Airbus A220-100 shown in the paper, what conclusions do you make about the utility of the all-electric aircraft operating in an airline network. Consider that the highest battery energy density today is around 600 Wh/kg.
- D) Comment on the mission profiles of the Airbus A220-100 and the all-electric commercial aircraft. Explain the tradeoffs of operating an all-electric aircraft in the mission profiles shown in the paper.
- E) Hart Aerospace is attempting to bring a hybrid electric aircraft to regional airliners. Examine their web site (<https://heartaerospace.com/es-30/>) and contrast their approach compared idea of an all-electric vehicle you read in part (a). Comment on the possible benefits of a hybrid-electric aircraft.