MAE 158 2022
Recommended Homework 7

From Anderson, *Aircraft Performance and Design*, Problem 5.11
From Shevell, *Fundamentals of Flight*
Problems 15.3, 15.6, 15.7

Recall from last week's homework:

The Bede BD-5J is a very small single-seat home-built jet airplane which became available in the early 1970s. The data for the BD-5J are as follows:

- Wing span: 17 ft
- Wing planform area: 37.8 ft^2
- Gross weight at takeoff: 960 lb
- Fuel capacity: 55 gal
- Power plant: one French-built Microturbo TRS 18 turbojet engine with maximum thrust at sea level of 202 lb and a specific fuel consumption of 1.3 lb/(lb·h)

We will approximate the drag polar for this airplane by

$$C_D = 0.02 + 0.062C_L^2$$

5.11 Consider the BD-5J flying at 10,000 ft. Assume a sudden and total loss of engine thrust. Calculate (*a*) the minimum glide path angle, (*b*) the maximum range covered over the ground during the glide, and (*c*) the corresponding equilibrium glide velocities at 10,000 ft and at sea level.

15.3. A four-engine 747 with a capacity of 365 passengers is cruising at a Mach number of 0.82 at a pressure altitude of 37,000 ft. Outside air temperature is −50°F. The initial cruise weight was 630,000 lb. According to the pilot's flight plan, he will start his descent at a weight of 488,000 lb. The 747 may be assumed to have a C_{D_P} of 0.0145, an e of 0.86, a wing area of 5500 ft^2, and a wing span of 195.7 ft. The compressibility drag coefficient, ΔC_{D_C}, at the average cruise weight is 0.0010. The JT9D-7 high bypass ratio turbofans have an installed specific fuel consumption at cruise of 0.65 lb/lb-h. Determine:

(a) Distance covered at cruise altitude (assume conditions at average cruise weight can be considered as the average for the flight).
(b) Required engine thrust, per engine, at the average cruise weight.
(c) Average cruise fuel flow in gallons per hour (kerosene fuel weighs 6.7 lb/gal).
(d) Seat-miles produced per gallon.
(e) Compare the 747 seat-miles/gal with a five-passenger automobile having a fuel consumption of 25 mi/gal.

Recall from last week's homework (15.2):

A two-place airplane is flying at a pressure altitude of 4000 ft at a speed of 120 mph. Outside air temperature is 50°F. The gross weight is 2000 lb. The rectangular wing has an area of 170 ft^2 with a span of 33.25 ft. Wing thickness is 14%. Wing parasite drag is 39% of the total parasite drag; 88% of the wing is exposed. Assuming a propeller (or propulsive) efficiency of 0.84.

15.6. The airplane of Problem 15.2 has an initial cruise weight of 2250 lb and will start its descent after consuming 430 lb of fuel in cruise. Specific fuel consumption is 0.48 lb/bhp-h. Determine the cruise range and endurance

15.7. At takeoff from San Francisco, a twin-engine DC-9-30 required a takeoff runway length of 5700 ft. The wing area is 1000 ft^2. The airport runways may be assumed to be at sea-level pressure altitude. The temperature was 72°F. The engines have a static ($V = 0$) rating of 14,500 lb of thrust each, but lose 14% in thrust at the effective average takeoff speed ($0.7\ V_{LO}$) due to bleed and power extraction losses and the engine ram drag due to forward speed. For the takeoff, the flap angle is 20 degrees, and the slats are extended

(a) Determine the takeoff weight.

(b) What is the lift-off speed at $1.2V_S$?

You may assume a $C_{L,max} = 2.53$

For problem 15.7:

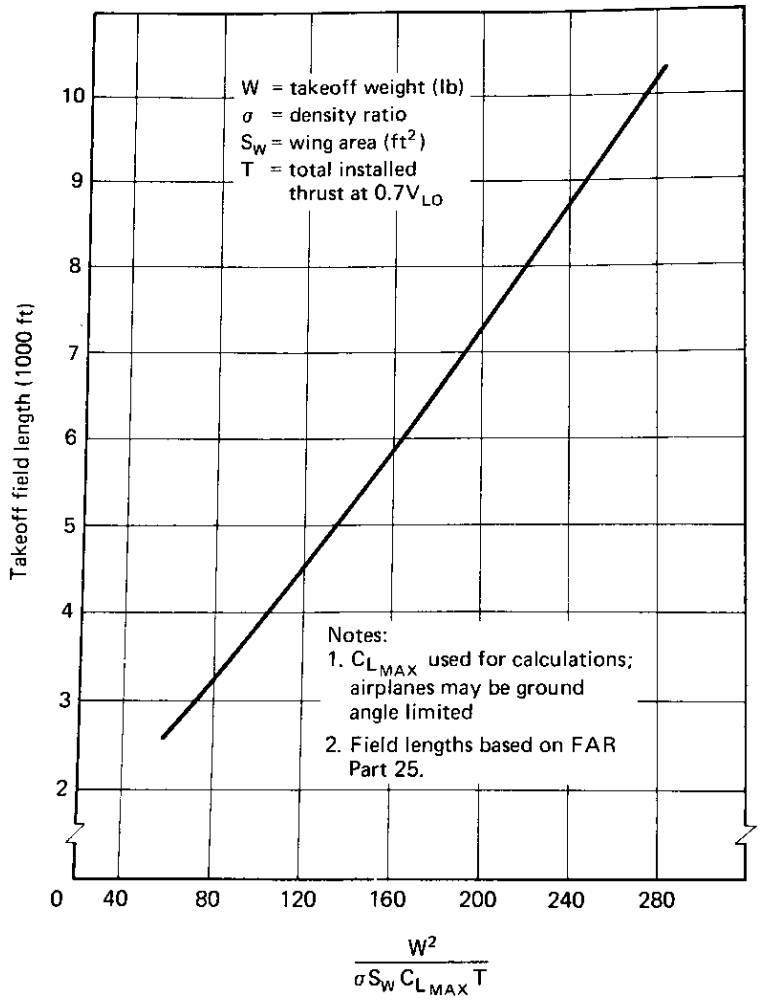

Figure 15.29 Two-engine jet aircraft FAR takeoff field length with engine failure.