Assignment 5: Flight Planning, ETOPS, and BADA Calculations

Due: February 28, 2024 Instructor: Trani

Problem 1

Check two instances of EVA Air flight 5 (EVA5). Use Flightaware to extract two flight plans filed on Thursday February 15, 2024 and Wednesday February 21, 2024.

a) State the aircraft used to fly the route.
b) Use Skyvector to plot the routes filed in the flight plans for both days. The flight plan waypoints are included in the Flight Data panel. Make a screen capture of the routes flown. You can shown the routes individually.
c) Use the Skyvector route and distance information to estimate the difference in distance flown for two flights. Provide some possible reasons for the observed changes in the routes flown.
d) For the EVA5 flight on February 21, 2024, estimate the number of climbs performed during the flight and the approximate time between climbs to burn fuel.

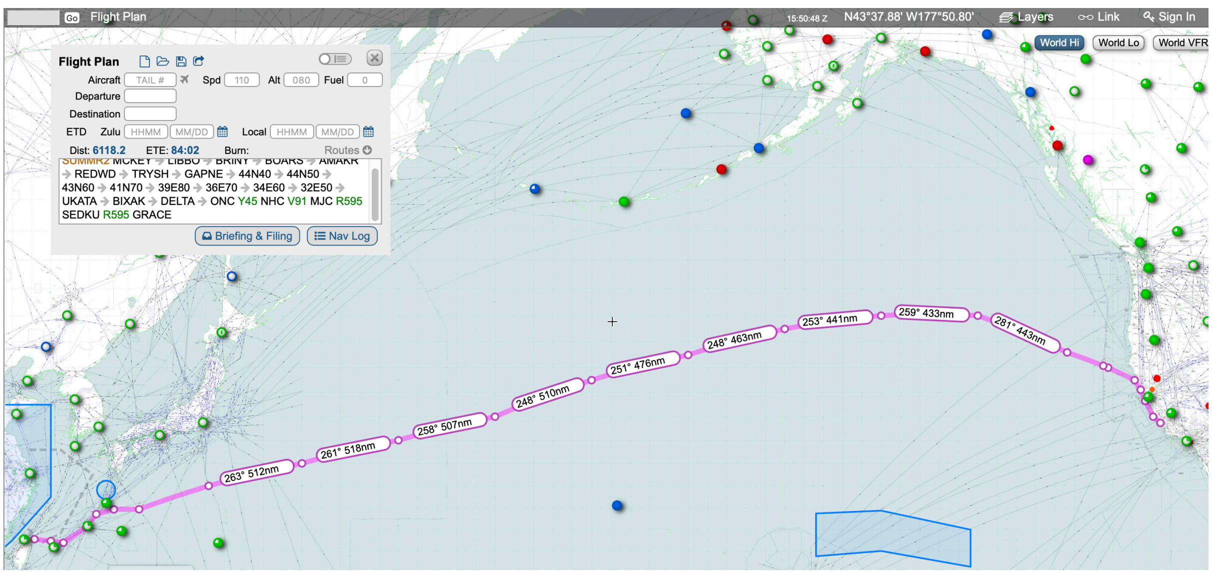

Figure 1. Flight Plan for EVA 5 on February 21, 2024.

At least five flight level changes detected in Flightaware. Started at FL 300 and the final altitude was FL 360. The number of flight level changes was probably seven for the flight.

Figure 2. Notes on Vertical Profile for EVA 5 on February 15, 2024.

Problem 2

Refer to pages 160-186 in the Aircraft Performance Notes 2 (section describing the BADA Model) to answer the questions. Figure 1 shows the descent profile of a UPS Boeing 767-300ER flying from Cologne to Philadelphia on February 13, 2024.

a) Find the fuel burn (in kilograms per minute) for the Boeing 767-300 according to the BADA model while the aircraft holds altitude at FL 200 and flying at a true airspeed of 395 knots. Assume the aircraft has a mass of 152,000 kilograms. Use the BADA model **clean** drag polar to estimate the fuel burn.

Drag (N) 105108.9
Fuel Burn (kg/min) 83.67
Cl (dim) 0.39068
Cd (dim) 0.027539
L/D ratio (dim) 14.18

b) Compare your answer against the value reported in the table on page 186 for the Boeing 767-300 at FL 200. Explain any differences.

At FL200 the PTF table reports 89.2 kg/minute at the nominal weight of 154.59 metric tons. The solution obtain is lower and consistent because the aircraft mass is 152 metric tons and the true airspeed is 395 knots its instead of the 413 knots stated in the table.

c) Find the total fuel burned in the altitude hold at FL200.

Total fuel used in the 10 minute hold is 836.7 kilograms

Problem 3

Use the new generation Transonic Truss-Braced Wing (TTBW) aircraft provided in class (http://128.173.204.63/cee5614/cee5614_pub/TTBW_class.m) to answer the questions. The TTBW flies a route between Vancouver (YVR) and Honolulu (HNL). The flight plan filed is as follows:

YVR ELMAA J70 HQM SEDAR A331 ZANNG A331 ZOULU A331 ZIGIE HNL

At waypoint ZINNO on airway A331 the aircraft has an engine failure. The aircraft is flying at FL 350 and Mach 0.76 when the engine failure occurs. At ZINNO, the TTBW has a mass of 63,000 kilograms and 7600 kilograms of fuel left. ZINNO is 1,008 nm from HNL and the pilot decides to continue the flight at a best single engine speed. The TTBW aircraft is certified for ETOPS 180 minutes.

a) Estimate the best true airspeed and Mach number to reach the destination at the best single-engine speed. Explain your speed and single-engine selection procedure. Avoid speeds that are on the back side of the drag curve. Assume zero winds along the route.
b) Find the fuel used to the destination airport from the point of engine failure.
c) Given the ETOPS criteria for the aircraft, can the route be flown legally? Explain.

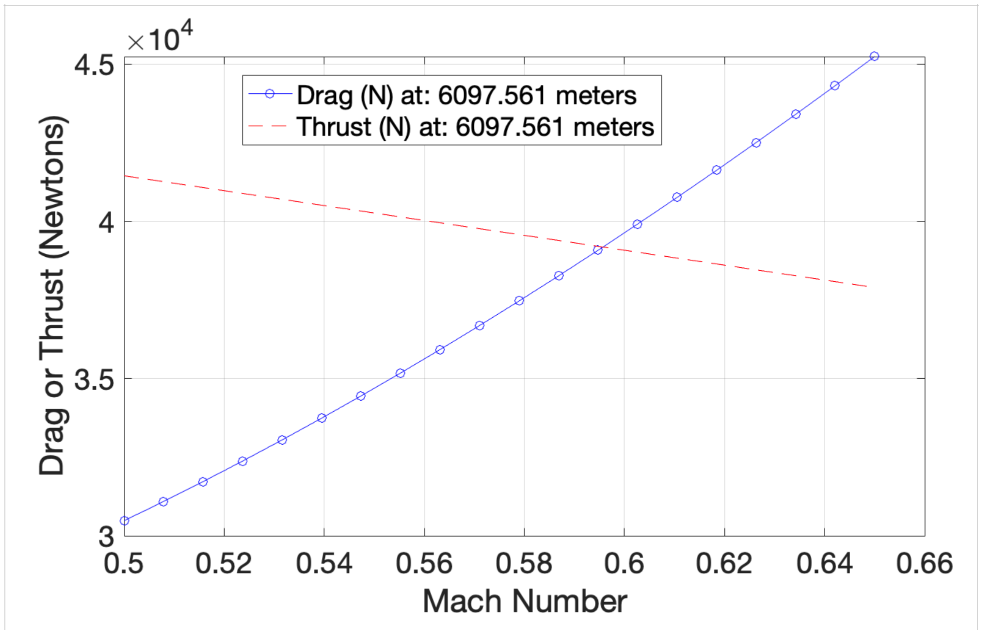

Figure 3. Thrust and Drag at FL 200.

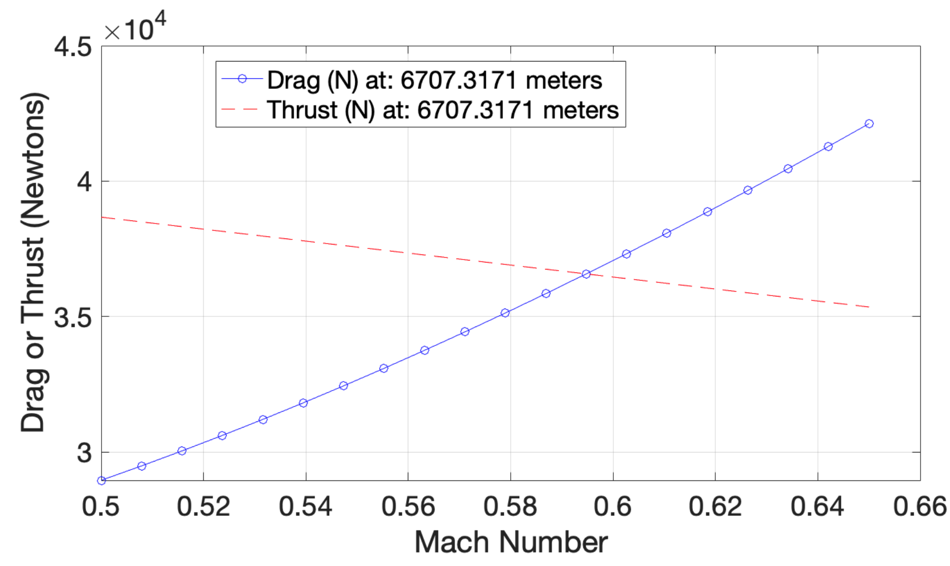

Figure 4. Thrust and Drag at FL 220.

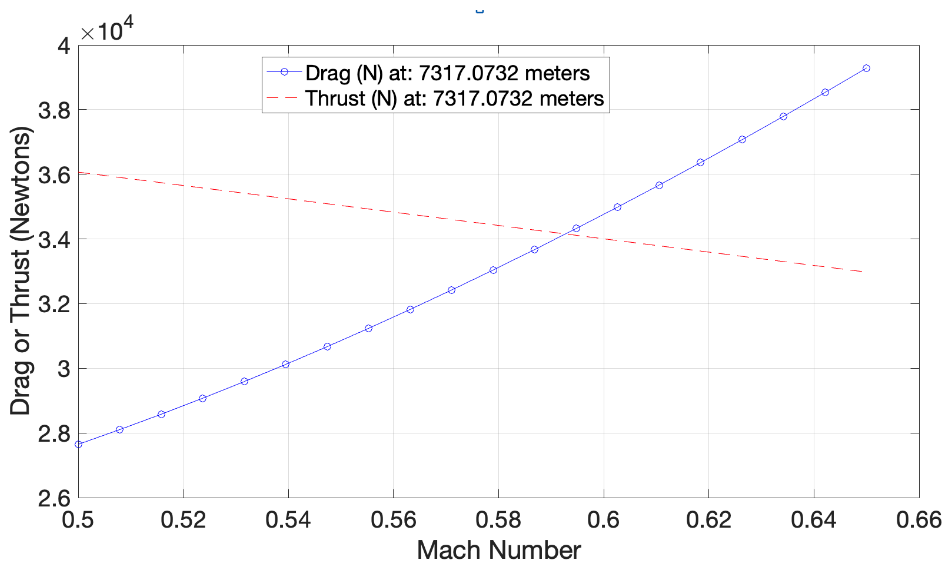

Figure 5. Thrust and Drag at FL 240.

Table 1. Performance with One Engine Out. Mach 0.56 Cruise.

Parameter	FL 200	FL 220
Drift down distance (nm)	72.0	63.0
Drift down time (min)	13.6	11.7
Drift down fuel used (N)	672	554
Speed at selected altitude	Mach 0.56 (343.3 knots)	Mach 0.56 (340.6 knots)

Speed of sound (m/s)	316.0	313.5
Descent time to sea level (min)	33.4	35.2
Fuel in descent from selected altitude to se a level (N)	3634.0	3749.0
Distance traveled to sea level (nm)	129.5	138.7
Total descent time (min)	47.0	46.9
Time left in cruise (min)	133.0	133.1
Total descent distance (nm)	201.5	201.7
Cruise distance (nm)	806.5	806.3
Cruise time at selected Mach number (min)	141.0	140.9
Total time to alternate (min)	188.0	187.8
Outcome	Exceeds 180 ETOPS limit	Exceeds 180 ETOPS limit

Conclusion:

The flight is not legal if flown at Mach 0.56 at FL 200 or FL 220. Mach 0.56 provides a modest margin of thrust over drag.

Table 2. Performance with One Engine Out. Mach 0.59 Cruise.

Parameter	FL 200	FL 220
Drift down distance (nm)	72.0	63.0
Drift down time (min)	13.6	11.7
Drift down fuel used (N)	672	554
Speed at selected altitude (Mach)	0.6	0.6
Speed of sound (m/s)	316.0	313.5
Cruise speed after engine failure (knots)	362.5	359.6
Descent time to sea level (min)	33.4	35.2
Fuel in descent from selected altitude to se a level (N)	3634.0	3749.0
Distance traveled to sea level (nm)	129.5	138.7
Total descent time (min)	47.0	46.9
Time left in cruise (min)	133.0	133.1

Total descent distance (nm)	201.5	201.7
Cruise distance (nm)	806.5	806.3
Cruise time at selected Mach number (min)	133.5	134.5
Total time to alternate (min)	180	181
Outcome	At the ETOPS limit	Close to 180 ETOPS limit
Cruise Fuel (kgs)	4068.5	4067.3
Total fuel used (kgs)	4507.4	4505.9

Conclusions:

1) The flight can be legal if flown at Mach 0.59 at FL 200. The descent profile can be modified to speed up the descent and shorten the flight). Mach 0.59 provides a slight margin of thrust over drag.
2) **The fuel used flying at Mach 0.59 at FL 200 is 4068.4 kilograms. The total fuel used in the flight to HNL is 4507.5 kilograms.**