Quiz 1 (Open Book/Notes)

Date Due: Thursday October 14, 2013

Instructor: Trani

Honor Code Pledge

The information provided in this exam is my own work. I have not received information from another person while doing this exam.

Signature _____

Show all your work. Create a PDF file and send to me by email.

Problem #1 (30 points)

The San Diego Airport Authority would like to request your services to study possible runway length improvements to runway 09-27. Review Airnav and the satellite images at Google Earth to answer the following questions. The goal of this exercise is to improve runway 09-27 allowing airlines to support international services and also to serve and some long-distance domestic destinations. Estimate the runway extension needed (if any) for runway 09-27 if the critical stage length services have been identified at this airport for various airlines (see Table 1).

More detailed information about the airport can be found at the AIRNAV database available on the web at: http://www.airnav.com/airports/. In your analysis use the latest version of the Boeing and Airbus documents for airport design (http://128.173.204.63/courses/cee5614/sites_ce_5614.html#Aircraft_Data).

Table 1. Typical Services from SAN to Critical Airports.

Origin-Destination Airport Pair	Aircraft Flying the Route
KSAN - SCEL San Diego - Santiago (Chile)	Boeing 767-400ER with *CF6-80C2B8* engines. Aircraft maximum design takeoff weight is 450,000 lb. Aircraft has a typical three-class configuration.
KSAN - HKG San Diego - Hong Kong	Boeing 787-8 powered by two *General Electric GEnx-1B* engines rated at 70,000 lb. of thrust. Aircraft maximum takeoff weight is 502,500 lb. Three-class layout.

a) Find the average stage length to be flown between each one of the critical OD airport pairs. In your analysis use the Great Circle Flight Path mapper link provided in our interesting web sites (see below). Add 6% to the distances calculated to account for real Air Traffic route conditions and to account for possible weather deviations from the optimal flight path.

b) Find the runway length needed for each one of the routes. Determine which one of the trips constitutes the critical stage length and design the new runway length extension if needed. Comment on your solution.

Problem # 2 (40 points)

Use the regional jet aircraft performance file provided in the Matlab files for CEE 5614 (http://128.173.204.63/courses/cee5614/cee5614_pub/regionalJet_class.m) to answer the following questions. This file represents a typical 50-seat regional jet powered by two turbofan engines developing 41,800 Newtons at sea level static conditions.

The airline would like to fly this aircraft from Roanoke, Virginia to Atlanta, Georgia using the climb and descent profile speeds stated below.

```
Vclimb = [160 190 240 270 270];            % Indicated airspeed in knots
Vdescent = [200 220 240 240 210];          % Indicated airspeed in knots
altc = [ 0 1000 3000 6000 14000];          % altitude vector in meters
```

The pilot files for a cruise altitude of 31,000 and Mach 0.71. The takeoff mass is comprised of the following:

Operating empty mass = 13,700 kg

Fuel weight onboard= 4,000 kg

Payload = 5,500 kg (50 passengers plus small amount of cargo).

a) Estimate the climb, cruise and descent distances for this flight. Account for a 6% detour factor due to weather and ATC deviations.

b) Estimate the fuel consumed and the travel time in the the route ROA-ATL.

c) Estimate the L/D ratio of the aircraft at both TOC and TOD points.

d) If the airline wants to fly a long distance with the aircraft, what speed (i.e., Mach number) would you recommend? Comment.

Problem # 3 (30 points)

Use the twin-engine jet aircraft performance file provided in the Matlab files for CEE 5614 (http://128.173.204.63/courses/cee5614/cee5614_pub/Boeing737800Jet_class.m) to answer this question. The file represents a typical 150 seat narrow body jet powered by two turbofan engines (CFM56 engines) similar in size to those of the Boeing 737-800.

Boeing is expecting to introduce the Boeing 737-8 Max in the year 2017. The aircraft has slight aerodynamic refinements (say a reduction in Cdo of 1%) with the use of better winglets and fuselage streamlining to reduce drag. Boeing estimates that the new CFM LEAP-1B engines will reduce the TSFC by 10% compared to the engines used today (i.e., ones in the aircraft performance file provided). This is a significant improvement (in paper) over the existing third generation of Boeing 737 aircraft like the 737-800.

a) Read a couple of short articles about the Boeing Max to get familiarized with the new generation aircraft Boeing is designing as a replacement of its existing narrow body fleet.

   http://www.boeing.com/boeing/commercial/737family/737max.page

   http://en.wikipedia.org/wiki/Boeing_737_MAX

b) Estimate the fuel savings of a combined 1% reduction in Cdo and 10% reduction in TSFC for the airline. Assume a typical airline uses Boeing 737-800 3,500 hours per year. In your analysis calculate the typical stage length flown by B738 aircraft using the NAS_operations file provided in HW 4 and use that stage length to estimate the typical fuel consumption of a Boeing 738-800 vs. the new Boeing 737-8 Max.

c) Estimate the fuel savings per aircraft if the typical airline pays $2.90 per gallon according to BTS (http://www.transtats.bts.gov/fuel.asp).