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| **Name** | **Team Number** |
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AAE 251: Introduction to Aerospace Design

Assignment 8—Aircraft Performance I

**Due Tuesday April 2, 10:00 am on Blackboard**

**Instructions**

*Write or type your answers into the appropriate boxes.* ***Make sure you submit a single PDF on Blackboard.***

*Make sure you keep a record of submission receipts or the confirmation emails after each submission as a proof that your submission was accepted.*

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|  | **Score** | **Max** |
| **Question 1** |  | **20** |
| **Question 2** |  | **4** |
| **Question 3** |  | **4** |
| **Question 4** |  | **16** |
| **Question 5** |  | **16** |
| **Question 6** |  | **10** |
| **TOTAL** |  | **70** |

Many aircraft performance questions require the same calculations. Creating the calculations as Matlab functions (not scripts) can save you effort in the homework and also help to hone your Matlab skills.

Create a set of well commented Matlab functions to implement the equations we gave or derived in class, i.e. :

* Lift, and drag as a function of velocity
* Thrust required in SLUF as a function of velocity for the jet from the case study
* Power required in SLUF as a function of velocity for the prop from the case study
* Thrust required in level-flight as a function of velocity, mass, surface area, e, AR, rho and zero-lift drag coefficient
* Power required in level-flight as a function of velocity, mass, surface area, e, AR, rho and zero-lift drag coefficient
* Any other functions you find you need in this homework

*Now use your Matlab functions to answer the following questions. Attach your* ***function and script*** *files and write your answers if needed as your response for each question. Make sure to show which functions you use, the values used in the function, and your final response.* ***Start each new question on a new page.***

**Question 1**

Plot the thrust and power required curves in SLUF for the two example aircraft we use in class (see the handout from class, or on BB). You may find Anderson Examples 6.1 and 6.3 useful in responding to this question. For the jet airplane, use = 50 m/s to 300 m/s, and use = 20 m/s to 150 m/s for the GA aircraft.

**Question 2**

Consider an aircraft modelled after the Cessna Citation X medium business jet aircraft. Its weight is 12000 N, wing area is 50 , aspect ratio is 7.8, Oswald efficiency factor is 0.86, and zero-lift drag coefficient is = 0.027. Calculate the thrust required to fly at a velocity of 720 km/hr at the height of:

(*a*) 4 km

(*b*) 10 km

Assume SLUF.

**Question 3**

An airplane weighing 5000 lb is flying at standard sea level with a velocity of 200 mi/hr. At this velocity, the L/D is a maximum. The wing area and aspect ratio are 200 ft2 and 8.5, respectively. The Oswald efficiency factor is 0.93. Calculate the total drag on the airplane.

**Question 4**

Consider an airplane patterned after the A-10. The airplane has the following characteristics: wing area = 505.6 ft2, aspect ratio = 6.5, Oswald efficiency factor = 0.87, weight = 23,105 lb, and zero lift drag coefficient = 0.032. The airplane is equipped with two jet engines with 9035 lb of static thrust *each* at sea level.

1. Calculate and plot the power required at sea level as a function of velocity.
2. Calculate the maximum velocity that can be achieved at sea level at maximum thrust.
3. Calculate and plot the power required at 5 km above sea level as a function of velocity.
4. Calculate the maximum velocity that can be achieved at 5 km above sea level at maximum thrust. (Assume that the jet engine thrust will be proportional to free-stream air density)

Answer 4:

Answer 4:

Answer 4:

Answer 4:

**Question 5**

Consider an airplane patterned after the Beechcraft Bonanza V-tailed single-engine light private airplane. The characteristics of this airplane are as follows: aspect ratio = 6.2, wing area = 16.82 , Oswald efficiency factor = 0.91, weight = 13380 N, and zero-lift drag coefficient = 0.027. The airplane is powered by a single piston engine capable of producing 345 hp at sea level. Assume that the power of the engine is proportional to free-stream air density and that the two-bladed propeller has an efficiency of 0.83.

1. Calculate and plot the power required at sea level as a function of velocity.
2. Calculate the maximum velocity that can be achieved at sea level at maximum power.
3. Calculate and plot the power required at 3.66 km above sea level as a function of velocity.
4. Calculate the maximum velocity that can be achieved at 3.66 km above sea level at maximum power. For this problem, assume that the jet engine thrust will be proportional to free-stream air density.

Answer 5:

Answer 5:

Answer 5:

Answer 5:

**Question 6**

Span loading is defined as the ratio of aircraft’s weight to its wing span. For an airplane in subsonic steady level flight, the drag force due to lift depends directly on the square of span loading through the relation

where *W* is the weight of the airplane, *b* is the wing span, *e* is the Oswald efficiency factor, and is the dynamic pressure.

1. Derive this relation.
2. Consider an aircraft with a wingspan of 37 ft and a gross weight of 10,000 lb. Assume that the Oswald efficiency factor is 0.8. The airplane is flying in steady, level flight at a velocity of 300 mi/h at a standard altitude of 5000 ft. Calculate the drag due to lift using the relation you derived.
3. What happens to the drag due to lift if the wing span is reduced to 34 ft? Why do you think the wingspan has an effect on the drag due to lift?

Answer 6:

Answer 6: