Flight Mechanics: Homework 1

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Policy

You should write your own answer/code by yourself. Cheating is highly discouraged for it could mean a zero or negative grade from the homework. If a question is not clear, please let us know via email.

Submission Instructions

Please submit your homework through the Ninova web site. Please zip and upload all your files using filename *studentID.rar*. You must provide all functions you wrote with your zipped file. Functions you do not submit may cause you lose a portion of your grade. Please make sure that you comment your code. Make also sure that the plots you produce are clearly readable and they have labels and legends. You must include the *report.pdf* file with your homework. Include there:

1. answers to the questions,
2. outputs for each question,
3. how to call your functions for each question.

Problems

In this homework, you are expected to implement a basic atmosphere model and functions for aerodynamic forces. You can find the required aircraft performance parameters in *aircraft.OPF* file. The equations and the structure of .OPF file are available in BADA 3.11 user manual.

Atmosphere Model and Operating Speeds

Using BADA3.11 user manual, solve the problems given below.

(a) Assume that geopotential pressure altitude (H_p) equals to geopotential altitude (H). Compute your outputs for both ISA conditions ($\Delta T = 0$) and non-ISA conditions ($\Delta T = -10^oC$). Then use expressions to calculate temperature T, pressure p, air density ρ and speed of sound a as a function of altitude H. Write a Matlab function ($f(H)$) that gives the temperature, pressure, air density and speed of sound. Plot the $H - T$, $H - p$, $H - \rho$ and $H - a$ graphs for altitudes below the troposphere.

(b) Write Matlab functions for CAS/TAS, TAS/CAS and Mach/TAS conversions. Use the conversion formulas defined at the manual. Plot the $V_{CAS} - V_{TAS}$ and $M - V_{TAS}$ graphs at 20000 ft.

Drag Polar Model

Using BADA3.11 user manual and aircraft.OPF file, solve the problems given below. Write necessary Matlab functions.

(a) Calculate the lift coefficient for level flight at $H = 33000ft$ with $V_{CAS} = 290kt$.

(b) Calculate the drag coefficient and the drag force at the same condition.

(c) Using stall speed, find the maximum lift coefficient C_{Lmax} at $H = 35000ft$.

(d) Plot the $C_L - C_D$ graph for $C_L \in [0, C_{Lmax}]$.

(e) Derive the expression between drag D and speed V. Plot the $V - D$ graph for the given aircraft at $25,000ft$ and $33,000ft$ for level flight (assume $L = W$).