Flight Mechanics: Term Project

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Due date: January 02, 2024

Policy: You can form a team up to three students or study alone to perform the term project. Your team should write your own answer/code. Cheating is highly discouraged; it could mean a zero or negative grade from the study. If you have a team, you should clearly indicate the assigned tasks for each team member and present the work distribution in your report.

Submission Instructions: Please submit your results through the Ninova website. Each team member must independently upload the team report and source codes to the system. Please zip and upload all your files using filename studentID.rar. You must provide all source codes you wrote with your zipped file. Source codes you do not submit will cause you to lose a portion of your grade. Please make sure that you comment on your code. Make also sure that the plots you produce are readable and they have labels and legends. You must include the report.pdf file containing the description of the method and implementation results.

Project:
In the project, we expect you to plan a flight trajectory between specified airports and analyze its performance. You will focus on a specific flight between assigned airports presented in Table 1. The flights are defined according to the last two digits of the student numbers. If you have a team, there will be three different flights according to your student numbers. In this case, you should focus on the longest range flight between them and perform the tasks only for this flight. Your flight should contain all flight phases from take-off to landing (i.e., take-off, climb, cruise, descent, and landing). Answer the following questions by performing the required analyses for your flight.

a) Choose an aircraft for your flight by performing the required calculations, explain your choosing strategy, and use the performance parameters of the selected aircraft for answering the following questions (Note: consider all flight phases including take-off and landing when choosing the aircraft)
b) Using the analytical expressions that you learnt, plan a trajectory for your flight. Specify a flight program for climb, cruise, and descent flight phases. Present the cruise profile and obtain the cruise speed. Obtain the speeds, vertical speeds and flight path angles during climb and descend flight phases by performing the required calculations. Obtain the total fuel consumption and flight duration for your flight.
c) Using the aircraft dynamic model (the set of equations) presented in homework 3 with the performance parameters of the aircraft chosen in part a, run a simulation to obtain the speed, vertical speed, flight path angle, and thrust profile with respect to time during the flight. The required control input could be calculated via the analytical expressions used in part c. Obtain the total fuel consumption and flight duration for your flight. (It is not

required to use the BADA to run the simulation, instead you can search in open literature to obtain a drag polar model or a simplified fuel consumption and thrust model for your aircraft. You can make assumptions as long as it is logical and you explain it properly)

d) Compare the results obtained in part b and part c using the $V_{tas} - Time, VerticalSpeed - Time, Mass - Time, Thrust - Time, FlightPathAngle - Time$ graphs, the total fuel consumption and flight duration. Discuss your findings.

Note that it is also expected from you to give a 5-minute presentation at the last lecture of the semester. Prepare a brief presentation to explain your approaches to solve the listed questions and give your results. The students who won't give a presentation will directly take a zero.

Note 2: It is not allowed to use Excel. You have to solve the problems using either MATLAB or Python.

Note 3: Grad students must form a team between themselves. The team formed by grad students cannot contain an undergrad student, or vice versa.

Note 4: All of the graphs that you obtained (in part a, b, c, or d) should be presented in Appendix section at the end of your report. **Your report cannot exceed 5 pages except Appendix**. You will lose 10 points for each extra page.

Table 1. Assigned Flight for Each Team/Student

Last Two Digits of Student Number	*Departure Airport*	*Last Two Digits of Student Number*	*Arrival Airport*
0X	JFK	X0	LHR
1X	HKG	X1	FRA
2X	ATL	X2	IST
3X	ORD	X3	AMS
4X	PVG	X4	SVO
5X	LAX	X5	CAI
6X	DAL	X6	DME
7X	HND	X7	CMN
8X	SIN	X8	ADD
9X	PEK	X9	CDG