EG418 Flight Dynamics I / Aircraft Performance

Spring 2008

Meetings: T/Th 1:00-2:20 PM
Location: DW 104

I.	**Instructors:**	Mohammad Sadraey, Doug Joyce
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	Office Hrs:	Sadraey: M-F 11:00-12:00 AM, other hours by appointment or drop-in. Joyce: T, Th 13:30 – 11: 30 AM other hours by appointment or drop-in.

II. Course Description: In this course, the equations of motion for steady state rectilinear flight will be derived, and then its applications for different flight condition are evaluated. The flight conditions in terms of pressure and temperature as functions of altitude and other atmospheric variables are introduced. The student will be able to calculate all performance specifications of an aircraft such as maximum speed, maximum endurance, range, ceiling, take-off run, rate of climb, fastest turn, tightest turn, and maneuvering flights. Both propeller driven and jet aircraft are covered. This course is offered in conjunction with the Division of Aviation. The students will conduct three experiments and evaluate the results and compare the flight test results with theoretical calculations. The second popular name for this course is "Aircraft Performance".

- **Prerequisite: MA205 (Differential Equations), EG210 (Aerodynamics)**

III. Required Texts:
Aircraft Performance and Design, Anderson J. D., McGraw-Hill, 1999

Recommended References:

a. **Flight Performance of fixed and rotary wing aircraft,** Filippone, A. AIAA, 2006
b. **Flight Testing of Fixed-Wing Aircraft**, Kimberlin R. D.**,** AIAA, 2003
c. **Airplane Aerodynamics and Performance,** Lan C. and Roskam J., DAR Corporation, 2003

IV. Objectives

To develop:

1. an understanding the model of atmosphere
2. the ability to calculate atmospherics variables in terms of altitude
3. the ability to apply equations of motion to different flight conditions
4. the ability to calculate forces that are applied on an aircraft
5. the ability to analyze aircraft performance in steady flight
6. the ability to analyze aircraft performance in accelerated flight
7. the ability to analyze aircraft performance for both jet and propeller driven aircraft
8. the ability to participate in a flight test to measure aircraft performance and evaluate the results

V. Outcomes

Upon completion of this class, the students will be able to:

1. model the atmosphere
2. able to calculate atmospherics variables in terms of altitude
3. know how to apply equations of motion to different flight conditions
4. able to calculate forces that are applied on an aircraft
5. analyze aircraft performance in steady-state flight
6. analyze aircraft performance in accelerated flight
7. analyze aircraft performance for both jet and propeller-driven aircraft
8. participate in a flight test and evaluate the results

VI. Expectations

1. You are responsible for all work covered in class, whether or not you are in attendance.
2. You are strongly encouraged to ask questions in class
3. You expected to read the assigned material before coming to class.
4. You and us are expected to show up on time for class.
5. You are encouraged to work together on homework and lab assignments, but not off of one another. All work on exams is to be done by the individual.
6. All members of the class will abide by the DWC Honor Code.
7. The classroom is to be a cooperative learning environment.
8. You should arrive in class with your textbook, your notebook, and a calculator capable of determining square roots every lecture section.
9. We will provide copies of old exams for you to look at.
10. We will post all assignments on Blackboard at least one day in advance.
11. The grades of all assignments are posted on Blackboard weekly.

12. The solutions of all assignments and tests are posted on Blackboard one day after its due date.
13. Professor Joyce will present a lecture to describe the objectives of the flight tests after the theory of the relevant tropic was introduced by Professor Sadraey.
14. For the fight tests purpose, you are divided in groups of two students each.
15. Each flight test group needs to prepare and present a briefing of their flight test plan prior to the flight test date to a committee that includes a group of professors and pilots. A flight test is permitted to be performed only after it is approved and signed by the committee members.
16. Each flight test group needs to prepare and submit a flight test report including the test evaluations after the flight test is performed.

VII. Course Policies

1. No late work will be accepted.
2. Any student found to be cheating during an exam will receive a failing grade for the class and will be reported to the Academic Dean.
3. We will happily work with you to reschedule an exam if you inform me of a conflict in advance. We are much less likely to reschedule an exam after the fact.

VIII. Evaluation

You will be evaluated in a number of different ways including homework, project, and examinations. The percentage breakdown of these pieces is as follows:

20 %	Homework
5 %	Class participation
20 %	Final Exam
30 %	Three Exams @ 10% Each
15%	Flight tests and evaluation reports
10%	Project

Grade Scale:

A/A-	$\geq$ 90%
B+/B/B-	80-89%
C+/C	70-79%
D	60-69%
F	< 60%

We will not make a determination of where the +/-'s will be until the end of the semester.

IX: Topics:

1. Atmosphere
2. Equations of motion
3. Drag force and its coefficient
4. Engine propulsive force
5. Straight line flight performance- jet aircraft
6. Straight line flight performance - propeller driven aircraft
7. Climb and descent
8. Turning flight
9. Take-off and landing
10. Maneuvering flight

X. Additional Assistance

1. Seek us out during office hours or set up an appointment
2. Use email to ask questions
3. Make use of the Writing Center
4. Work with one another outside of the classroom
5. Consult with the Academic Support Center

XI. Academic Honesty

While it is assumed that no student would submit any material, be it homework, quiz, exam or any other assignment for grading which is not solely her/his own work, the following policy shall be implemented in cases of academic dishonesty:

- First offense, all persons involved will receive no credit for the assignment or test. The VPAA will also be notified of this action.
- Second offense, all persons involved will receive a grade of F for the course.

XII. Americans with Disabilities Act

Students with any type of disability that may require accommodation should contact the instructor as early in the semester as possible to discuss the needs. In addition, as mandated by Federal Law, if you require any modifications or accommodations for this class, please contact the Director of Academic Resources to fill out the appropriate paperwork.

XIII. Homework Policy

Homework provides you with an opportunity to practice the materials that are covered in class in order to develop facility with the materials and to provide ongoing preparation for tests. It also provides an opportunity for you to develop and hone your technical communication skills.

1. There will be a weekly homework. It will be due the same day the following week.
2. Homework will be collected at the beginning of class.
3. Late homework will not be accepted and will result in a grade of zero for that assignment. If you are late for class and homework has been collected at that point, yours will be considered late and not accepted.
4. Show all your works. This includes references, figures, equations, substitutions, units, and final answer.
5. Your writing must be legible. You are expected to use correct spelling, grammar, and punctuation.
6. Your work must be neat, orderly and uncrowded, without a lot of erasures and no frazzled page edges.
7. Only the material relevant to the homework must be in the submitted work.
8. Each homework page should include page number and must be arranged in numerical order.
9. Each problem is to begin with a problem number and problem statement, followed by your work. You must provide enough written explanation so that the grader can follow your work.
10. The grade on homework assignments will be based both on the technical quality of your work and the written presentation of the work.
11. Generally, each problem should start on a new page. However, for short problems, you may put more than one on a page, but no more than three.
12. In using any equation, the reference must be addressed. If the equation is not from any reference (e.g. textbook), the derivation must be clearly illustrated. For example, if the derivation has used new forces or new coordinate system, a figure is needed.
13. Always perform the sanity check. If the result of a problem is highly off limit, there is a negative point on that. For example, if the wing area of an aircraft is found to be 10,000,000,000 m^2, this is clearly wrong. Thus the results must be reasonable.
14. In the calculation process, the number of digits after decimal point must be reasonable. For example, if the answer is between 10 and 20, you cannot use more than two digits after the decimal point. If the answer is in the order of 1,000,000, you should not use any decimal at all. For example the answer of x =

8.249874564874 has a negative point. Thus you must round the answers to the nearest number.

15. Be consistent. For instance, you should not use a symbol (i.e. a) for two different purposes in the same problem.

16. Do not manipulate the numbers. You must be change the numbers to looks right. A wrong answer is far better than a manipulated number.

17. Always show unit of any answer.

18. Draw a box around the final answer.

19. If you are drawing a technical device, it must look like the real one to the outside observer. For instance the drawing of an aircraft must not look like a car.

20. If you are including a figure in your assignment, it must have figure number, plus figure name. Furthermore, each coordinate must have a name, numbers and a unit.

21. The division of each coordinate must be reasonable. For example a coordinate of a figure cannot be divided into only two pieces or into 500 pieces. Some thing around 5 to 10 pieces is reasonable.

22. Do not include any page or any writings that is not related to the assignment.

23. If the homework assignment is more than a page, the pages must be stapled or tied together or bound. If the papers are stapled, nothing must be under staples.

24. Each homework assignment must have at least homework number, name of the student, course name (and course code), and date of submission.

25. If you are using an engineering software (i.e. MathCad, Excel,…), make sure you know its principles.

26. If you are using MathCad, the length of an equation must not exceed one page.

27. If you are using MathCad, show the answer of each equation with the relevant unit.

28. If you are using Excel, you must show all equations in a separate space, since the Excel only prints the results.

29. If you are not using an engineering software for your calculation, you must show all substitutions.

30. Do not include any unused number, unused calculation and unused figure in your assignment.

31. If you type the homework assignment, you will earn extra 10% in the grade of that assignment.

XIV. Project Report Format

1. Most items in section XIII (Homework policy) apply to a project report.
2. A project needs a separate first page, a table of contents, list of symbols (with their names and units), and references at the end.

3. Divide your project into less than 10 sections. Each section must have a number and a name.
4. A project needs to have an introduction and a problem statement.

XV. Calendar

Week	Date	Topic	Chapter	HW/Test/ FT
1	1/16 – 1/18	Atmosphere	Hand-out	
2	1/21 – 1/ 25	Atmosphere, **Intro to Flight Test**	Hand-out	HW 1
3	1/28 – 2/1	Equations of motion	Hand-out, Ch 4, S. 5.9	HW 2
4	2/4 – 2/8	Drag force, **Pitot-Static Calibration**	Hand-out	Flight Test 1
5	2/11 – 2/ 15	Drag coefficient, Engine propulsive force	Hand-out, Ch 3	HW 3
6	2/18 – 2/22	Steady level flight	5.1 – 5.4	**Test 1**
7	2/25 – 2/29	Maximum velocity	5.5	HW 4, Project Report -Part 1
8	3/3 – 3/7	Climb and descent	5.10	HW 5
	3/10 – 3/14	**Spring Break**	-	-
9	3/17 – 3/21	Ceiling, **Saw-Tooth Climb/Level Acceleration**	5.11	HW 6**,** Flight Test 2
10	3/24 – 3/28	Range	5.13	**Test 2**
11	3/31 – 4/4	Endurance	5.14	HW 7
12	4/7 – 4/11	Turning flight, **Turn Performance**	6.1 – 6.2	Flight Test 3, HW 8
13	4/14 – 4/18	Maneuvering flight	6.3 – 6.5	HW 9
14	4/21 – 4/25	Take-off and landing	6.7	HW 10
15	4/28 – 5/2	Test 3, Review		**Test 3, Project report**
16	5/5 – 5/9	Finals	-	**Final test**