COURSE SYLLABUS STEM Ed Abroad Program

Course Title:	Aeronautical Engineering- Aerospace Vehicle Performance
Course Semester:	Fall
University and Country:	Adam Mickiewicz University; Poznan, Poland
Number of ECTS:	6 (lecture)
For transfer credit to:	MAE251 (NCSU)

Content: Introduction to the problem of performance analysis in aerospace engineering. Aircraft performance in gliding, climbing, level, and turning flight. Calculation of vehicle take-off and landing distance, range and endurance. Elementary performance design problems. Introduction to space flight.

Pre-requisites: Cumulative GPA 2.5 or higher and a grade of C or better in both Calculus II and Physics I. Basic skills in computer programming through completion of a course in Matlab and basic computer skills.

Course overview

• Fundamental physical quantities, anatomy of an airplane and a space vehicle
• The standard atmosphere • Basic aerodynamics, conservation of mass. momentum and energy in flows, Bernoulli's equation, Mach number
• Airfoil and wing aerodynamics, aircraft drag estimation 1
• Elements of aircraft performance • Introduction to aircraft stability and control, propulsion
• Introduction to space flight
• Introduction to flight vehicle design Objectives
After completing the course, the student will have the ability to:
• Calculate properties of the standard atmosphere
• Use Bernoulli's theorem in duct flow and airspeed measurement, calculate Mach number
• Estimate aircraft drag using simple drag-build-up approach
• Estimate aircraft performance parameters (level flight, climb, glide, takeoff, landing, maneuvers)
• Explain the different parts of an aircraft in relation to stability and control
• Analyze space orbits and maneuvers
• Understand the complexity associated with design Assignments, Grading, Projects, Attendance, etc.

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Instructors in POZNAŃ:

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Consultant at NCSU:

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Books: Required:

http://wolfware.ncsu.edu Textbook • John D. Anderson, "Introduction to Flight," 8th Edition, McGraw Hill. Earlier editions (5th to 7th) of this textbook will also be acceptable. When HW problems are assigned from the textbook, it is assumed that the problems are from the 8th edition. Those students who are using a different edition will need to obtain the correct problems.

Grading System and Percentage Contribution

Approximately 5–6 homework assignments will be handed out. They will need to be completed in 1–1.5 weeks as per the deadline provided in the homework. Late homework will not be accepted. (20%)

In-class midterm tests tentatively on 27 September and 1 November. (10% + 10%)

Pop quizzes, usually at the beginning of classes. Some pop quizzes will be administered in class via Moodle. All students will need to bring to every class a laptop (or tablet or other device) from which they will be able to access Moodle to take the quiz. No make-ups for pop quizzes. (5%)

Projects (25%): It is anticipated that we will have 3–5 projects in the course. The projects are intended to provide a venue for application of concepts learned in the course either by implementation as a computer program or by use of an existing software for aerodynamic analysis. Roughly, a typical project will have double the weight of a typical HW. Projects may also involve some off-line learning using materials not discussed in the lectures, such as pre-recorded video lectures and internet-based user guides. Possible projects are: computer program for standard atmosphere, computer program for aircraft performance, design-build-fly project of a glider or rocket, simulation of orbits, and simple exercise to illustrate vehicle design. Dates to be decided (TBD).

A comprehensive final examination. (30%)

Attendance is compulsory for all tests and examinations. No make-up tests or examinations except for a certified medical reason. Portions of some homeworks, quizzes, projects, tests and exams may be administered using computer-based systems such as Moodle. The instructor may chose to grade only some homeworks, projects, and pop-quizzes (or portions of those). These will be selected for grading randomly. The grades for homeworks, projects, and pop-quizzes will be decided on those portions that are selected for grading. Students are expected to complete all problems in all homeworks, projects, and pop-quizzes. Solutions will be posted or discussed in class for the entire homework and pop-quiz, including portions not selected for grading.

AMU Grading system and scale

The grading system used at Adam Mickiewicz University, whose name is abbreviated as AMU or UAM, is as follows:

Tests, exams, homework assignments grading scale

5	100%-91%
4+	90%-86%
4	85%-76%
3+	75%-71%
3	70%-60%
2	59% and less

This translates into the following ECTS (European internationally recognized system) grading scale:

ECTS Grade	AMU grade	Definition
A	5.0	EXCELLENT – outstanding performance with only minor errors
B+	4+ / 4.5	VERY GOOD – above the average standard but with some errors
B	4.0	GOOD – generally sound work with a number of notable errors
C+	3+ / 3.5	SATISFACTORY – fair but with significant shortcomings
C	3.0	SUFFICIENT – performance meets the minimum criteria
F	2.0	FAIL – considerable further work is required

Hours: 3 Lecture hours hour per week.

Approximate timetable for homework

Week	Topic	Assignment
1	Introduction to the class and the design process	
2	Model development Forces and Earth’s atmosphere Fundamentals of aerodynamics	HW 1
3-4	Airfoils and wings	HW 2
5 -6	Measures of aircraft performance	HW 3
7	Measures of aircraft performance	HW 4

8-9	Introduction to structural analysis	HW 5
9	Aircraft propulsion	HW6
10	Aircraft stability and controls	HW7
11	Fundamentals of orbital mechanics	HW8
12	Orbital maneuvers	HW9
13	Rocket propulsion	HW10

Lectures :

	Week #	**Time**	**Topics**
Aug	**1**	3x70 min	Course introduction, Anatomy of aircraft, Anatomy of spacecraft, Fundamental physical quantities, Standard atmosphere, Discussion of computer program for standard atmosphere, Spacecraft anatomy, basics of space trajectories and propulsion systems used in Astronautics
Sept -Oct	**2**	3x70 min	Pressure, temperature, and density altitudes, measurement of pressure Basic aerodynamic concepts: – Basic definitions (steady/unsteady flow, incompressible/compressible flows, – streamline, streamtube) – Conservation of mass – Conservation of momentum, Bernoulli's theorem – Measurement of airspeed, pitot-static system
	3	3x70 min	– Flow similarity, forces and force coefficients – Criteria for dynamically similar flows: Reynolds number and Mach number Lift vs. drag, inviscid vs. viscous flows – Compressible flow phenomena
	4	3x70 min	Basic aerodynamic concepts: – Compressible flow phenomena continued – Overview of boundary layers – Pressure drag vs. skin friction drag – Bluff-body vs. streamlined-body flows – Subcritical vs. supercritical cylinder flows **1st mid-term exam**
	5	3x70 min	Overview of airfoil aerodynamics Mid-Term Test
	6	3x70 min	Overview of wing aerodynamics Aircraft drag estimation
Nov	**7**	**2x70 min**	Aircraft drag estimation exercise and project
	8	**2x70 min**	Estimation of aircraft performance: – Equations of motion – Level, unaccelerated flight – Thrust available and required, power available and required

			2nd mid-term exam
	9	**2x70 min**	Estimation of aircraft performance: Range and endurance, best speeds Climb, glide, and ceilings Takeoff and landing
	10	**2x70 min**	Estimation of aircraft performance: Turning flight and V-n diagram Aircraft performance calculation and design problems; aircraft performance project
	11	**2x70 min**	Introduction to spaceflight mechanics – Kepler's laws, basic orbits – Overview of launch, reentry, and manned spaceflight
	12	**2x70 min**	**Course review**
	13	**180 min**	**Final test**
Sum:		30x70 min (around 2100 minutes) + finals	