AE 6355 - Syllabus

Planetary Entry, Descent and Landing, 3 Credits

General Information

Description

Entry flight mechanics and dynamics, aerothermodynamics, thermal protection systems, aerodynamic decelerators, descent, and landing. Robotic and human exploration mission studies for aerobraking, planetary entry, aerocapture.

Pre- &/or Co-Requisites

No pre-requisite

Course Goals and Learning Outcomes

Upon successful completion of this course, the student should be able to:

1. Be fluent in the common terminology used in the field of Entry, Descent, and Landing.
2. Approximate the lift and drag coefficients of a hypersonic, blunt body entry vehicle.
3. Simulate the flight trajectory of both ballistic and lifting entry vehicles in any planetary atmosphere.
4. Assess the aerodynamic heating environment in the stagnation point region of a blunt body entry vehicle.
5. Define the thermal protection system requirements for a blunt body entry vehicle.
6. Define the requirements for terminal descent: parachutes, propulsion, and landing systems.

Course Requirements & Grading

Note: Graded components of a course may vary with each offering. The example below is typical but subject to change.

Description of Graded Components

Assignment	Date	Weight (Percentage, points, etc)
Homework	Bi-weekly	20%
Mid-term exam	Mid-semester	25%
Final project	Last class day	30%
Final Exam	Finals week	25%

Homework: Homework is assigned to provide students with an opportunity to apply the theoretical material discussed in the lectures to practical applications. Homework dissemination, submission, and due dates will be managed electronically via Canvas. Late homework will in general not be accepted without prior approval. In-class verbal or Canvas due date announcements override projected dates in the lecture plan. Homework should be professional, legible, indicate units, and sufficiently describe all important steps in a solution.

Your final answer for each problem should be boxed or otherwise clearly indicated. Electronic submissions will be done via Canvas and should also include any source code used to obtain your solutions (if applicable).

Deductions will be made for incomplete solutions and improper formats. Details on submission instructions will be provided in the homework assignment description. Note that some assignments will require heavy use of Matlab or other programming language, and students are responsible for familiarizing themselves with Matlab and/or another programming language.

Exams: As with homework solutions, exam solutions should be legible, include units, and sufficiently describe all important steps in a solution. Put your name and page number on each page, and 'box' your final answer for each problem. Deductions will be made for incomplete solutions and improper formats. Additional instructions and restrictions for each exam will be discussed in class and will be clearly identified on the exam coversheet. In general, exams are closed-book, meaning that you are to complete the exam without the aid of textbooks, hand-outs, class notes, cellular telephones, personal digital devices, or computers/software. Use of a pocket (non-programmable) calculator and one 8.5" x 11" page of notes is allowed.

Computer Project: An individual computer project will be assigned prior to the mid-term exam and is designed to give students the opportunity to apply the course material to a topic of their choice. More detail will be provided on the scope and content of the project and report, but the final report should emulate a journal-style manuscript in both style and format. The report will be assessed on the relevance, novelty, and technical quality of the analysis done, as well as the presentation of the results in the report (a formal grading rubric will be provided).

Grading Scale

Your final grade will be assigned as a letter grade according to the following scale:

A	90-100%
B	80-89%
C	70-79%
D	60-69%
F	0-59%

Topics Covered

Note: The exact topics covered in a course may vary with each offering. The example below is typical but subject to change.

Aeroassist Mission Classes and Definitions

Hypersonic Aerodynamics

Atmosphere and Gravity Models

Basic Orbital Mechanics and Minimum Energy Deorbit Trajectories

Ballistic Entry Flight Mechanics

Lifting Entry Flight Mechanics

Bank Angle Modulation and Atmospheric Maneuvers

Numerical Simulation

Aerothermodynamics

Thermal Protection Systems

Terminal Descent and Propulsive Descent

Parachutes and Aerodynamic Decelerators

Course Materials

Note: Course materials may vary with each offering. The example below is typical but subject to change.

Textbook

Recommended: Regan & Anandakrishnan, *Dynamics of Atmospheric Re-Entry,* AIAA Education Series, 1993.

Reference: Vinh, Busemann and Culp, *Hypersonic and Planetary Entry Flight Mechanics*, 2nd edition, University of Michigan Press, 1980

Reference: Anderson, John D., *Hypersonic and High Temperature Gas Dynamics*, 3rd Edition, AIAA Education Series, 2019

Course notes

Couse notes and other materials are posted online to Canvas.