

AE 6353: Orbital Mechanics

Fall Semester 2007

Instructor: Dr. Robert D. Braun
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321-3 Knight Building

Class Schedule: MWF 1:05 – 1:55 pm, ESM 210

Textbooks: Required: Bate, Mueller and White, *Fundamentals of Astrodynamics*, Dover, 1971.
Reference: Wiesel, *Spaceflight Dynamics*, 2nd edition, McGraw Hill, 1997.
Reference: Curtis, *Orbital Mechanics for Engineering Students*, Elsevier, 2005.

TA: Grant Wells
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217 Knight Building

Instructor Office Hours: MW 3:00 – 4:00 pm

TA Office Hours: TR 10:00-11:00 am

Course web site: <http://www.ae.gatech.edu/people/rbraun/classes/astroI07/index.html>

Prerequisites: None

Course Overview:

AE 6353 is the first in a series of two graduate-level astrodynamics classes offered at the Georgia Institute of Technology. Course content includes historical background and equations of motion, two-body orbital mechanics, orbit determination, orbit prediction, orbital maneuvers, lunar and interplanetary trajectories, orbital rendezvous and space navigation. The course grade is based on the student's performance in two in-class midterms, a final exam and eight homework sets.

Each homework assignment will be due at the beginning of the lecture, one week from the date it is handed out. No late homework assignments will be accepted. Homework should be legible, professional and demonstrate all important steps in the solution. Use only one side of the page and indicate page numbers and your name on each page. Clearly indicate your final answer by enclosing it in a box. Be sure to indicate units. Deductions will be made for improper homework formats.

Midterm 1 will cover historical background and equations of motion, two-body orbital mechanics, orbit determination, orbital maneuvers and Kepler's problem (Chapters 1-4 in the BMW text). Midterm 2 will cover Gauss' problem, lunar, interplanetary trajectories and gravity assist trajectories (Chapters 5, 7 and 8 in the BMW text). All class material (including the restricted three-body problem, orbital rendezvous and space navigation) will be covered in a comprehensive final during finals week. All tests employ a closed book, closed notes format. Chapters 6 and 9 of the BMW text are not assigned. Supplemental reading from the Wiesel and Curtis texts is recommended.

Class lectures will be videotaped and broadcast for distance learning students at the National Institute of Aerospace or other locations.

Grading:

The course grade will be based on homework, two midterms and a final

Midterm 1 – October 12

Midterm 2 – November 19

Final – Dec 14, 2:50-5:40 pm

The overall grade will be determined using the following percentages:

Homework	20%
Midterm 1	25%
Midterm 2	25%
Final	30%

Grades between 90% and 100% will be an A; 80% to 89.99% will be a B; etc. Class attendance and participation may be considered in borderline cases.

Key Class Dates:

Aug 20	First day of class
Sept 3	Fall holiday, no class
Oct 8-9	Fall recess, no class on Oct 8
Oct 12	Midterm 1
Nov 19	Midterm 2
Nov 22-23	Thanksgiving break, no class on Nov 23
Dec 7	Last day of class
Dec 14	Final exam (2:50-5:40 pm)
Dec 17	Grades posted

Other Noteworthy Events:

Aug 4	Phoenix Mars Scout launch
Sept	Dawn launch period
Nov 12	Dave Spencer: Mars Phoenix Scout mission campus lecture

Lecture Topics:

The following is the draft set of lecture topics. Content adjustments are expected during the semester based on schedule progress.

Aug 20	Course overview and historical perspective
Aug 22	Newton's law of gravitation, N-body problem, Two-body problem
Aug 24	Two-body problem
Aug 27	Two-body trajectory equation; Conic sections
Aug 29	Elliptical and circular orbits; handout Homework #1
Aug 31	Parabolic and hyperbolic orbits; Canonical units
Sept 3	Fall holiday, no class
Sept 5	Coordinate systems
Sept 7	Classical orbital elements

Sept 10	Orbital elements to/from position and velocity; coordinate transformations
Sept 12	The measurement of time; handout Homework #2
Sept 14	Orbit determination from observations
Sept 17	Orbit determination from observations
Sept 19	Orbit determination from observations; Differential correction
Sept 21	Ground tracks
Sept 24	Oblateness effects on low-altitude orbits; handout Homework #3
Sept 26	Orbital maneuvers
Sept 28	Orbital maneuvers
Oct 1	Position and velocity as a function of time; handout Homework #4 (Grant)
Oct 3	Kepler's problem (Steinfeldt)
Oct 5	Universal variable solution to Kepler's problem
Oct 8	Fall break, no class
Oct 10	Problem session (Wells)
Oct 12	Midterm 1
Oct 15	Universal variable solution to Kepler's problem
Oct 17	Gauss' problem
Oct 19	Gauss' problem – p-iteration technique
Oct 22	Gauss' problem – universal variable formulation; handout Homework #5
Oct 24	Practical Applications of Gauss' problem: Mission Design, Rendezvous/Intercept Phase Angle and Synodic Period (Russell)
Oct 26	Patched conic approximation
Oct 29	Patched Conic approximation for interplanetary transfer
Oct 31	Patched Conic approximation for interplanetary transfer
Nov 2	Gravity assist trajectories; handout Homework #6
Nov 5	Gravity assist trajectories
Nov 7	The Earth-Moon system; Simple lunar transfers
Nov 9	Patched conic approximation for lunar transfer
Nov 12	Patched conic approximation for lunar transfer
Nov 14	Problem session (Wells)
Nov 16	Midterm 2
Nov 19	Lunar free-return trajectories; handout Homework #7
Nov 21	Lunar free-return trajectories, Michelson chart
Nov 23	No class, Thanksgiving break
Nov 26	The restricted 3-body problem as applied to lunar transfer
Nov 28	Periodic orbits and AE 6354 introduction (Russell)
Nov 30	The restricted 3-body problem; handout Homework #8
Dec 3	Lagrange equilibrium points, Orbital rendezvous
Dec 5	Orbital rendezvous (Wells)
Dec 7	Orbital rendezvous

Unless otherwise indicated, this class meets at time and place assigned, each MWF during the semester. Lectures will be presented by Dr. Braun unless otherwise indicated.

Academic Conduct (Honor Code):

Overall academic conduct is governed by the Georgia Tech Honor Code (<http://www.honor.gatech.edu>). The intent of the Honor Code is to prevent any student from gaining an unfair advantage over other students through academic misconduct. Students are expected to act according to the highest ethical standards. Students should review the Honor Code and be familiar with its expectations regarding cheating, misrepresentation of student work, and plagiarism. Students shall commit to uphold the ideals of honor and integrity by refusing to betray the trust bestowed upon them as a member of the Georgia Tech community.

In this course, students are encouraged to meet in small groups outside the classroom to discuss course-related topics and issues. Discussion of homework problems is acceptable. However, no sharing of any part of a homework solution is allowed. Eavesdropping, copying or stealing of another individual's intellectual content is not permitted. Plagiarism from past editions of this course is also prohibited.

The programming functions available on many calculators may not be used during the class midterms and final to store or iteratively solve equations.

Students found in violation of the Honor Code will face significant reductions in their course grade and be referred to the VP of Student Affairs for disciplinary action.