AOE 4134 – Astromechanics – Fall 2006

Instructor: Dr. Hanspeter Schaub, Randolph Hall 228, 231-1413, schaub@vt.edu

Lectures: MWF 8:00am – 8:50am, Randolph 221 (90319)
. MWF 11:15am – 12:05am, Randolph 216 (90318)

Office Hours: MW 9:30am–10:30am, Thursday 1:30pm-2:30pm (or by appointment)

Final Exam: TBD (common exam time for both sections)

Text: H. Schaub and J. L. Junkins, *Analytical Mechanics of Space Systems*, AIAA Education Series, 2003. (errata sheet on http://homepage.mac.com/hanspeterschaub/work/books.html)

Course Web Page: on the VT blackboard system

Overview: Application of Newtons Laws to the dynamics of spaceflight. Two-body problem, Keplers Laws, energy and time relations, orbit specification and determination. Orbital maneuver and transfer, patched conic approximations, relative motion, and elements of optimal maneuvering. This course is normally taught in the fall semester. It involves three hours of classes per week and is worth three semester credits. ESM 2304 is a prerequisite. *Note: you must have received a C- or higher in your prerequisite course to take AOE 4134.*

Goal: To introduce you to the problems associated with analyzing, predicting and controlling the orbital dynamics of spacecraft.

Homework Policy: Each homework assignment is due on the specified due date and must be turned in at the beginning of the lecture. Normally, late homework will not be accepted. Some homework will require simple programs to be created. These can be done in Matlab, Maple, Mathematica, C, or Fortran. See instructor if not sure about the software package being used. The homework you turn in must be your own work, and reflect your level of knowledge of the subject matter. Grading corrections must be noted within 2 weeks.

Exams: There will be two mid-term exams and one comprehensive final exam.

Class Attendance: You are expected to attend class. If you need to miss a lecture, it is your responsibility to catch up on the material. Don't go to the instructor to catch up on missed material, speak with class mates and get the notes from them.

Make-Up Policy: There are no make-up homework assignments. If you miss the assignment, you get a zero for it. If you can't make an exam for a pressing reason, you need to contact the instructor *one week prior* to the exam date. If you can't take the exam for some emergency reason, you still need to notify the instructor prior to the exam. Without prior consent, there will be no make-up exams.

Grading Policy: A conventional ten-point system will be used for grading. If I feel it necessary, I will curve the exam scores to reflect the difficulty level of the problems assigned. Thus, your final assigned scores on each set of papers is your true grade and should be interpreted on a 100 point scale (i.e. A(90-100), B(80-89), C(70-79), D(60-69), F(below 60)). Subgrades of "+" and "-" will be assigned at instructors discression. The exam with your *highest* score will be weighted with an additional 5%. The percent worth of exams and class assignments are:

Homework/Quizzes – 20%
Exam 1 – 25%
Exam 2 – 25%
Final Exam – 25%
Mystery Points – 5%

Honor Code: The University Honor Code will be maintained. You are encouraged to discuss homework assignments with your instructor, teaching assistant, and classmates. However, all work submitted for a grade must reflect your own understanding of the material. You may not copy answers to homework problems and you may not assist others or seek assistance on exams.

Special Needs: If you need adaptations or accommodations because of a disability (learning disability, attention deficit disorder, psychological, physical, etc.), if you have emergency medical information to share with me, or if you need special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible.

Estimate of Topics Covered

Introduction Review of vector notation, basic particle kinematics, Newton's laws

Geometry of Classical Orbits Learning how to describe geometry of elliptical, parabolic and hyperbolic orbits.

Orbit Equations of Motion Deriving the satellite equations of motion.

Fundamental Integrals Apply the conservation of momentum and energy to the orbital motion to determine convenient constants (invariants) of the motion.

Kepler's Equation Learn how to relate time of flight to the angular position of the satellite.

Orbit Elements Learn how to map between invariants of motion and the traditional position and velocity vectors. Learn how to interpret 2-line element sets. J_2 perturbation of orbit elements (critical orbit, sun-synchronous orbit).

F and G solution Learn how to apply the F and G solution to determine the orbital motion.

Earth Observed Motion Determine the satellite ground track, compute the sidereal time, determine satellite visibility from Earth.

Orbit Determination Determine a satellite orbit from Earth based observations.

Minimum Energy Orbit Transfer Learn how to transition between two orbits using a minimum energy maneuver or a Hohmann transfer for circular orbits.

Orbit Plane Change Learn how to change the orbit plane angle.

Patched Conic Orbit Solution Learn how to fly between the planets, includes departure and arrival motion.