AOE 4140 – Spacecraft Dynamics and Control – Spring 2007

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

Lectures: MWF 11:15pm–12:05pm, Randolph 216

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

Final Exam: May 9, 2005, 2:05pm–4:05pm, Randolph 216

Text: H. Schaub and J. L. Junkins, *Analytical Mechanics of Space Systems*, AIAA Education Series, 2003.

Course Web Page: on the VT blackboard system

Overview: Space missions and the pointing requirements affect attitude control systems. Rotational kinematics and attitude determination algorithms. Modeling and analysis of the attitude dynamics of space vehicles. Rigid body dynamics, effects of energy dissipation. Gravity gradient, spin, and dual spin stabilization. Rotational maneuvers. Environmental torques. Impacts of attitude stabilization techniques on mission performance. AOE4134 and AOE3034 are prerequisites.

Goal: To introduce students to the dynamics and control of problems of pointing 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. If a homework has been graded incorrectly, you need to see me within 2 weeks of having the homework returned to you.

Exams: There will be two exams and one comprehensive final exam. If you have exam grading issues, you must see me within 2 weeks of having the exam returned to you.

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 or 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, Vector Differentiation

Mission Analysis Learning how to specify pointing requirements and introduction to attitude error budgets.

Rigid Body Kinematics Learn how to describe three-dimensional rigid body (coordinate frame) orientations, derive kinematic differential equations, integrate attitude motion, learn about different coordinate choices

Attitude Determination Learn what observable vectors are. Develop algorithms to determine the rigid body attitude from a set of measurements.

Rigid Body Kinetics Develop the equations of motion of a rigid body. Develop the inertia matrix. Study energy and momentum concepts. Look at stability of free-spinning body.

Satellite Dynamics Look at gravity gradient stabilized spacecraft. Study single- and dual-spin spacecraft stability.