AOE 6235
Spacecraft Dynamics and Control
Spring 2006

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

Lectures: MWF 2:30pm–3:45pm, Randolph 116

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

Final Exam: May 10, 2006, 10:05am–12:05pm

Text: H. Schaub and J. L. Junkins, *Analytical Mechanics of Space Systems*, AIAA Education Series, 2003. (please download the errata sheet from the web page http://homepage.mac.com/hanspeterschaub/work/books.html)
Course notes supplied on the class blackboard web site.

Course Web Page: on the VT blackboard system

Overview: Rigid body kinematics and spacecraft attitude descriptions. Attitude dynamics, motion about the center of mass, gravity gradient, and stability. Methods of attitude control both active (momentum exchange devices, thrusting) and passive (spin stabilization). Small and large angle feedback control laws. Attitude maneuvers of hybrid bodies containing both rigid and flexible components. Pre: AOE 5204, or permission of instructor. (3H, 3C)

Goal: To introduce students to the spacecraft attitude dynamics, kinematics, as well as control.

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 a mid-term exam 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. There will also be two course projects which will require you to write a technical report. These reports must be type written and composed as a professional technical report.

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)). I will assign "+" and "-" grades at my discretion 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%
Project – 25%
Mid-Term – 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.

Estimate of Topics Covered

Introduction Review of vector notation, Vector Differentiation, Euler angles

Spacecraft attitude coordinate choices direction cosine matrix, Euler parameters, modified and classical Rodrigues parameters

Spacecraft equations of motion Use momentum and energy equations for rigid bodies

Linear and nonlinear attitude control of rigid bodies Learn how to exploit attitude coordinate descriptions to create regulator and tracking feedback control laws.

Momentum exchange devices Develop equations of motion of satellite with multiple VSCMGs.

Flexible spacecraft equations of motion Use Hamilton's principle to develop the equations of motion and boundary conditions of a hybrid rigid body/flexible component system.