SYLLABUS FOR AE 5382/MAE 4301: Advanced Astronautics

Course (Catalog) Description: AE 5382: Advanced Astronautics (3-0) 3 hours credit. To learn about concepts and advances in Orbital mechanics and Astrodynamics and apply them to past, current and futuristic space missions. The emphasis will be on solution techniques and algorithms for Orbit determination and estimation, Orbital maneuvering and perturbation methods. Topics include the restricted three body problem, Lagrangian points, effects of J2, atmospheric drag and solar radiation pressure on spacecraft formation flight

Prerequisites: MAE 3304 or MAE 3405 or equivalent

Instructor: Dr. Kamesh Subbarao, Associate Professor, Mechanical and Aerospace Engineering Dept., 315 G Woolf Hall,(817) 272 7467, Office hours: By Appointment, Email: subbarao@uta.edu

Teaching Assistant: None

Office Hours: TuTh 11:00 AM - 12:30 PM

Textbook and/or other required material: There is no prescribed textbook but the following are good references for the material to be covered in this course.

- Battin, R. H., "An Introduction to the Mathematics and Methods of Astrodynamics", AIAA Education Series
- Vallado, D., "Fundamentals of Astrodynamics and Applications", Second Edition, Space Technology Library
- Schaub, H., Junkins, J. L., "Analytical Mechanics of Space Systems", AIAA Education Series
- Bate, Roger R.; White, Jerry E.; Mueller, Donald, "Fundamentals of Astrodynamics", ISBN: 0486600610, Publisher: Dover Publications
- William E. Wiesel, Spaceflight Dynamics, ISBN 0070701105 Publisher McGraw-Hill Science/Engineering/Math
- AIAA Journal of Guidance Control and Dynamics `http://arc.aiaa.org/loi/jgcd`
- Journal of Astronautical Sciences `http://link.springer.com/journal/40295`
- Celestial Mechanics and Dynamic Astronomy `http://link.springer.com/journal/10569`
- **Software**: MATLAB Student Edition/Control Toolbox by Mathworks Inc.

Class Schedule: NH 109, TuTh 2.00 PM - 3.20 PM.

Contribution of course to meeting the professional component: Engineering science - 3 hours credit.

Course Objectives

- Develop mathematical models that astrodynamics problems.

- Develop algorithms and techniques to enable orbit transfers.
- Develop guidance and navigation laws for space missions.
- Analyze effect of perturbations on long duration missions.

Course Content:

- General solution of the Two-Body problem.
  - Initial Value Problems
  - Solutions to Kepler's Equation
  - Boundary Value Problems
- Hodograph analysis, Lambert's Problem
- Non-Keplerian Motion
  - Lagrange's solution to the Three-Body Problem
  - Restricted Three Body Problem
  - Stability of Lagrangian Points
  - Disturbing Function and Sphere of Influence
  - Spacecraft Motion under Continuous Thrust
- Patched-Conic Orbits and Perturbation Methods
  - Approach Trajectories, Interplanetary Orbits, Circumlunar Trajectories
  - Osculating Orbit and Encke's Method
  - Linearization and the State Transition Matrix.
  - Precision Free-Return Orbits
- Gauss' Form of Variational Equations
  - Effect of J2, Solar Radiation and Atmospheric Drag on Satellite Orbits
- Two-Body Orbital Transfer
  - Single, Two Impulse transfers.
  - Mid course corrections and optimal guidance laws
- Space Navigation
  - Orbit determination
  - Estimation algorithms

Course Requirements:

Attendance- Class attendance is required.

Final Examination- The final examination will be **comprehensive** and test you on all aspects of the material covered in the class.

Homework- A number of homework assignments will be given during this course. Homework is due in class on the assigned date before the actual class begins. Late homework will not be accepted, unless in cases of unforseen circumstances such as medical conditions. Each such instance will be dealt with on a case by case basis. MATLAB/SIMULINK will be used extensively for homework. Students are allowed to discuss concepts. Any other form of collaboration such as sharing code, results is not allowed.

Project- There will be one project that illustrates concepts discussed in the class. For the project, you may either reproduce the results of a Journal Article (not authored by you) or choose to work on a problem in consultation with the instructor. The topic for the project has to be chosen and approved by the instructor on or before February 18, 2014.

Grade Allocation: Grading follows the standard format. $A = 90\%$ and above, $B = 80\% - 89\%$, $C = 70\% - 79\%$, $D = 60\% - 69\%$.

Weightages for final grade calculation: Final 25%; Homeworks 50%; Project 25%.

University Policies:

Email to Faculty- To contact a faculty member use the email address provided in the syllabus. Use as the "subject line": [AE5382]. Put your name inside the email message, start with the main point/question of the message. Emails from outside the UTA domain are subject to be treated as SPAM by the server and deleted. Unsigned emails will not be replied to and will be deleted.

Student Evaluation of Teaching- You will be asked to complete feedback forms at the end of the semester.

Absences Based on Religious Beliefs- A student who misses an examination, work assignment, or other project due to the observance of a religious holy day will be given the opportunity to complete the work missed. To be eligible for such a make-up the student must notify his/her instructor in writing within the first 15 days of class. Failure to follow the rules provided above within the time frames listed will result in the absence being considered unexcused.

American with Disabilities Act- The University of Texas at Arlington is on record as being committed to both the spirit and letter of federal equal opportunity legislation; reference Public Law 93112 – The Rehabilitation Act of 1973 as amended. With the passage of new federal legislation entitled Americans With Disability Act - (ADA), pursuant to section 504 of The Rehabilitation Act, there is renewed focus on providing this population with the same opportunities enjoyed by all citizens. As faculty members, we are required by law to provide "***reasonable accommodation***" to students with disabilities, so as not to discriminate on the basis of that disability. Student responsibility primarily resets with *informing faculty at the beginning of the semester and in providing authorized documentation through designated administrative channels*. For more information contact the Office of Students with Disabilities at 817-272-3364.

Academic Dishonesty- It is the philosophy of The University of Texas at Arlington that academic dishonesty is a completely unacceptable mode of conduct and will not be tolerated in any form. All persons involved in academic dishonesty will be disciplined in accordance with

University regulations and procedures. Discipline may include suspension or expulsion from the University. "Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts." (Regents Rules and Regulations, Part One, Chapter VI, Section 3, Subsection 3.2, Subdivision 3.22)

Student Support Services Available- The University of Texas at Arlington provides a variety of resources and programs designed to help students develop academic skills, deal with personal situations, and better understand concepts and information related to their courses. These resources include tutoring, major-based learning centers, developmental education, advising and mentoring, personal counselling, and federally funded programs. For individualized referrals to resources for any reason, students may contact the Maverick Resource Hotline at 817-272-6107 or visit `www.uta.edu/resources` for more information.

Inclement Weather Policy- In the event the weather or other conditions are such that normal campus operations could be impeded the following policy will apply for this class. If the University is closed this class will not meet. Any assignments due or examinations scheduled will be due or rescheduled to the very next class period that the class meets. Local media should announce any such closings. You can also get information by dialing (972) 601-2049

Notice- The instructors reserve the right to make changes to the course syllabus as necessary. It is the student's responsibility to keep up with the changes to the syllabus as posted on the class website.