ASE 387P
MISSION ANALYSIS AND DESIGN (13495)

SPRING 2011

Class Meeting Period: MWF 2-3 PM
Class Meeting Location: WRW 413

Instructor: Wallace Fowler
Office Hours: MWF 8:30-9:40 AM & MWF 3-4 PM
fowler@csr.utexas.edu
WRW 415D

GRACE Mission Plan – to be available on the course Blackboard website
plus selected Instructor's Notes on special topics – to be available on the Blackboard website

Evaluation Method:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Homework Problems</td>
<td>20 %</td>
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<tr>
<td>Mission Analysis Tools</td>
<td>20 %</td>
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<tr>
<td>Mission Outreach Assignment</td>
<td>10 %</td>
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<tr>
<td>Mission / Spacecraft Design</td>
<td>50 %</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td>100 %</td>
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CRITICAL DATES:

- Last Drop Day for Possible Refund - Feb 2, 2011
- Last Drop Day without penalty - Feb 2, 2011
- Spring Break - Mar 14-19, 2011
- Registration for Summer/Fall - Apr 18-29, 2011
- Last Day of Class - May 6, 2011

EXAMINATIONS: No examinations. The end-of-term mission plan / spacecraft design or mission design tool development takes the place of the final exam.

ATTENDANCE: Regular attendance is expected.

OFFICE HOURS: Office hours are MWF 8:30-9:45 AM and MWF 3-4 PM (other times by appointment). You can stop by at any other time and if I am free, I will see you. If I am not available, you can schedule an appointment with me via e-mail (fowler@csr.utexas.edu) or by phone 471-4257. I am usually at the Center for Space Research on Tuesdays and Thursdays.

PREREQUISITES: There are no formal prerequisites for this course. However, a solid understanding of orbital mechanics at the undergraduate level is required. This understanding can be obtained through formal coursework or individual study.
SPECIAL NOTES: The University of Texas at Austin provides upon request appropriate academic adjustments for qualified students with disabilities. For more information, contact the Office of the Dean of Students at 471-6259, 471-4641 TDD or the College of Engineering’s Director of Students with Disabilities at 471-4321.

SCHOLASTIC DISHONESTY: The College of Engineering has no tolerance for acts of scholastic dishonesty. By teaching this course, I have agreed to observe all the faculty responsibilities which pertain to academic dishonesty. By enrolling in this class, you have agreed to observe all the student responsibilities which pertain to academic dishonesty. If the rules pertaining to academic dishonesty in this class are unclear in any way, it is your responsibility to seek clarification. Specifically, the policy states:

Policy on Scholastic Dishonesty: Students who violate University rules on scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and/or dismissal from the University.

Since dishonesty harms the individual, all students, and the integrity of the University, policies on scholastic dishonesty will be strictly enforced. You should refer to the Student Judicial Services website at http://www.utexas.edu/depts/dos/ or the General Information catalog to access the official University policies and procedures on scholastic dishonesty as well as further elaboration on what constitutes scholastic dishonesty.

RELIGIOUS HOLY DAYS: A student who misses an examination, work assignment, or other project due to the observance of a religious holy day will be given an opportunity to complete the work missed within a reasonable time after the absence, provided that he or she has properly notified each instructor. It is the policy of the University of Texas at Austin that the student must notify each instructor at least fourteen days prior to the classes scheduled on dates he or she will be absent to observe a religious holy day. For religious holidays that fall within the first two weeks of the semester, the notice should be given on the first day of the semester. The student may not be penalized for these excused absences but the instructor may appropriately respond if the student fails to complete satisfactorily the missed assignment or examination within a reasonable time after the excused absence.

EVALUATION: The Measurement and Evaluation Center forms for the College of Engineering will be used during the last week of class to evaluate the course and the instructor. From time to time, and especially if the lecture that day has dealt with a difficult concept, I may ask you to spend one or two minutes at the end of class and write down “what you understood well and what you did not understand well in today’s class”. That way, when we do a “recap” at the beginning of the next class I can focus on what you had difficulty with. In addition, comments on how improvements can be made are welcome at anytime.

BIOGRAPHICAL SUMMARY:

You should write a one page autobiographical summary to be turned in at the fifth class period. This summary should include when and where you were born and where you went to school. It should cover your jobs, your early schooling, your college education, your interests and skills, and what you want to do after you get out of school. You can attach a copy of your current resume if you have one. The biographical summary should be submitted in electronic form -- Microsoft Word attached to an e-mail. Send it to me at fowler@csr.utexas.edu. You can submit the document electronically if you so desire.
TOPICS TO BE COVERED:

A broad range of topics are covered in this course. Topics are selected on the basis of student interest, instructor interest, current events, and design project needs. The order that the topics are covered will depend on the focus of class mission planning activities. Topics which have been covered in past semesters include:

- Top-Down Design
- Basic Orbits / Space Environment / Parabolic and Hyperbolic Trajectories / Solar system
- Orbit Elements / Low Earth Orbits / Special Orbits / Sun Synchronous / J2 effects in LEO / Node Tables
- Groundtracks / Communications
- Orbital Maneuvers / Hohmann Transfers / Plane Changes / LEO - GEO Problem Optimization
- Orbital Maneuvers / Fixed ΔV Maneuvers / Trajectory Planning
- Rendezvous / Phasing
- Proximity Operations / Hill's (CW) Equations
- GRACE Mission & Launch Considerations / Launch Windows
- GRACE Mission Overview / GRACE Considerations / Mission Planning Software
- Proximity Operations / GRACE Separation
- Proximity Operations / GRACE Reboost
- Proximity Operations / GRACE Satellite Exchange Maneuver
- Lambert Targeting / Pork Chop Plots / Broken Plane Transfers
- Spacecraft Lighting
- Patched Conics / Planetary Missions / Gravity Assist
- Launch and Injection Windows
- Rockets / Characteristic ΔV / Serial and Parallel Staging
- Launch Modeling / Gravity Turn / Gravity and Drag Losses
- Choosing a Booster (Delta / Titan / Saturn / Proton / Airanne / Energia / Pegasus / Atlas / etc.)
- Shuttle Missions / Standard Orbits Document
- Shuttle Maneuver Capabilities / Shuttle Communications / Shuttle Rendezvous
- Space Station Operations
- Atmospheric Entry / Satellite Lifetime LEO / LLO
- Earth-Moon System / Apollo Scenarios / Earth-Moon Trajectories - Free Return
- Lunar Orbit Characterization
- Space Sensors
- Communications

PUBLIC SCHOOL OUTREACH ASSIGNMENT:

For this assignment, you must contact a public school teacher and offer your services to aid in promoting science, mathematics, and/or engineering to the students. You should focus on any space-related topic that is agreed to by you and the teacher of the class you visit. When a match of your resources and talents and the teacher’s needs is identified, do what is needed. If no match is found, contact another teacher. The only reporting requirements are a one page description of the activity from the graduate student and a note from the teacher assessing the effectiveness of the contact. The report is due two weeks before the end of the semester. If you have a problem with making public presentations, an alternative assignment is available. See your instructor about this.
MISSION ANALYSIS TOOL DEVELOPMENT & HOMEWORK:

You will be asked to do regular homework exercises and to develop mission analysis tools. In these exercises, we will simulate the way that mission planning and support usually arises in the real world. You will develop mission planning and analysis tools to aid you in planning your team missions. Many of the tools we develop will be useful in to class team design. The computer software that we will use is TK Solver. I will initiate the process by providing a basic set of tools. Our goal is to develop a set of mission planning tools useful for the mission you are planning this semester plus providing you with tools to use in your careers.

GRACE:

We have the opportunity study the actual mission plan for the GRACE mission. This is an exposure to a real mission plan which will provide us with information useful in our mission plans and spacecraft design. Some of the technical areas that we need to know about to understand the GRACE mission plan are:

- The Space Environment
- Orbital elements / rectangular cartesian coordinates
- Coordinate transformations among various coordinate sets
  - Earth centered / Earth fixed, J2004, Topocentric, azimuth & elevation, etc.
- Orbit Design / Ground Tracks
- Proximity operations
- Satellite fields of view / lines of sight -- Earth Coverage
- Orbit perturbations / precession / sun synchronous orbits
- Earth and lunar shadows
- Consumable Budgets
- ΔV budget
- Launch capability analysis
- Current booster capabilities
- Current launch sites
- Payload to orbit analyses (effects of orbit height, orbit inclination, etc.)
- Orbital debris

The GRACE mission plan will be available on the class Blackboard website under Course Documents.

The Mission / Spacecraft Conceptual Designs / Mission Design Tools

You will work, either as individuals, small groups, or as the entire class to develop (1) a conceptual design for a mission and spacecraft or (2) develop a mission design tool for use by students in subsequent classes. The conceptual missions and/or design tools must be approved by the instructor.