Syllabus for ME 597 Small Spacecraft Design I (3 credit hours)

Instructor: Dr. T. Alan Lovell

Contact: lovelta@unm.edu

Text: *Space Mission Engineering: The New SMAD,* Edited by: Wertz, Everett, and Puschell, Microcosm Press, 2011.

Small Spacecraft Design I. This course introduces engineering students to the design of complex space systems, integrating space science and engineering material. The course covers the fundamentals of each of the subsystems in a spacecraft, such as propulsion, the spacecraft structure, attitude determination and control, thermal control, and the space environment. This course has no formal prerequisites.

Goal: The goal is to expose students to the fundamentals of each of the subsystems in a spacecraft to a depth that permits students to carry out the conceptual design of a spacecraft to meet specified mission objectives

Objectives: Students will be able to identify spacecraft payloads and missions.
Students will be able to apply spacecraft dynamics to mission analysis and design.
Students will be able to design spacecraft subsystems to meet mission objectives.
Students will be able to communicate effectively.

Assignments

Writing Assignments: There will be three reports assigned at various times during the semester, and each will be due one or more weeks after they are first assigned. Late submissions will not normally be accepted and will receive a grade of 0. In the event of family or work emergency, please contact me before the due date to discuss arrangements for late submission. Grading rubric and examples will be included with each assignment.

Design Presentation: At the start of the semester, students will be given a specific mission to design to, and throughout the semester will accumulate data regarding their choice of components, orbit, operations, etc, for their satellite. A slide presentation on their design is due at the end of the semester.

Quizzes: Quizzes will be conducted intermittently throughout the semester. Most quiz questions are graded automatically by Canvas. However, some questions (such as "essay" questions) will require me to grade.

Matlab: Proficiency using Matlab or other programming environment (such as Python or Mathematica) is not required, but may be helpful for some of the assignments in the course. Matlab is available to all UNM students at http://it.unm.edu/download/

Make-Up Policy: There are no make-up assignments. If you miss the assignment, you get a zero for it. If you cannot meet a due date, you must contact me *before* the due date. Without prior arrangement, there will be no opportunity to make up the missed points.

Grading Policy:

Quiz Average	20%
Report #1	20%
Report #2	20%
Report #3	20%
Design Presentation	20%

Grading Scale: The grading scale is given below, where the numbers are the percentage of the total weighted grades as defined in the Grading Policy above.

98-100	A+

93-97.99	A
90-92.99	A-
87-89.99	B+
83-86.99	B
80-82.99	B-
77-79.99	C+
73-76.99	C
70-72.99	C-
67-69.99	D+
63-66.99	D
60-62.99	D-
Below 60	F

Topics: *Learning Outcomes*

Space Systems Design

Students will be able to list and describe the steps in the spacecraft design process. 2.

Introduction to Astrodynamics

Students will be able to quantify relationships between space flight dynamics and space mission requirements.

The Space Environment

Students can describe the key environmental factors affecting the operation of a space system operating in Earth orbit, and can relate these factors to design requirements.

Spacecraft Propulsion

Students can describe the basic types and applications of spacecraft propulsion systems, and can apply basic techniques for preliminary design and sizing of propulsion systems.

Launch Vehicles

Students can relate mission requirements to launch vehicle selection.

Attitude Determination and Control

Students can describe the basic types and applications of spacecraft attitude determination and control systems. Students can apply basic techniques for preliminary design and sizing of ADCS systems.

Structures and Mechanisms

Students can describe the typical interfaces and environmental effects that a spacecraft structural design must accommodate. Students can apply basic techniques for preliminary design and sizing of structural systems.

Power Systems

Students can describe the basic types and applications of spacecraft power systems. Students can apply basic techniques for preliminary design and sizing of power systems.

Thermal Control

Students can analyze the thermal environment and its effects on a spacecraft and its subsystems. Students can apply basic techniques for preliminary design and sizing of active and passive thermal control systems.

Communications

Students can describe the fundamental elements of radio communications used for spacecraft. Students can organize and compute a link budget for a space application. Students can apply basic techniques for preliminary design and sizing of communication systems.

Small Spacecraft Design

Students can integrate all course design topics into a single small spacecraft design.

Schedule of Topics:

Week One: *Introduction and Overview of Spacecraft Design; Basic Orbital Dynamics*

Week Two: *Mission Analysis; Space Environment*

Week Three: *Space Propulsion; Launch Vehicles*

Week Four: *Attitude Determination and Control; Structures and Mechanisms*

Week Five: *Power Systems; Thermal Control*

Week Six: *Communications*

Week Seven: *Small Satellite Design*

Week Eight: *Wrap-up*

Supplementary References:

- P. Fortescue and J. Stark (editors), Spacecraft Systems Engineering, 2nd edition, 1997, Wiley.
- V. L. Pisacane and R. C. Moore (editors), Fundamentals of Space Systems, Oxford University Press, 1994.

Attendance Policy: Regular "attendance" and participation is required. UNM Pathfinder policies apply, which in part means instructor drops based on non-attendance are possible. This policy applies regardless of the grading option you have chosen.

Drop Policy: This course falls under all UNM policies for last day to drop courses, etc. Please see https://dos.unm.edu/resources/general-faq.html or the UNM Course Catalog for information on UNM services and policies. Please see the UNM Registrar webpage for Semester Deadline Dates: http://registrar.unm.edu/

Academic Integrity: The University of New Mexico believes that academic honesty is a foundation principle for personal and academic development. All University policies regarding academic honesty apply to this course. Academic dishonesty includes, but is not limited to, cheating or copying, plagiarism (claiming credit for the words or works of another from any type of source such as print, Internet or electronic database, or failing to cite the source), fabricating information or citations, facilitating acts of academic dishonesty by others, having unauthorized possession of examinations, submitting work of another person or work previously used without informing the instructor, or tampering with the academic work of other students. The University's full statement on academic honesty and the consequences for failure to comply is available in the college catalog and in the *Pathfinder*: http://pathfinder.unm.edu/campus-policies/academic-dishonesty.html

Accommodation Statement: Accessibility Services (Mesa Vista Hall 2021, 505-277-3506) provides academic support to students who have disabilities. If you think you need alternative accessible formats for undertaking and completing coursework, you should contact this service right away to assure your needs are met in a timely manner. https://arc.unm.edu/ If you need local assistance in contacting Accessibility Services, please contact the

Mechanical Engineering Department using the contact information located near the top of this Syllabus.

Title IX Statement: In an effort to meet obligations under Title IX, UNM faculty, Teaching Assistants, and Graduate Assistants are considered "responsible employees" by the

Department of Education. This designation requires that any report of gender discrimination that includes sexual harassment, sexual misconduct and sexual violence made to a faculty member, TA, or GA must be reported to the Title IX Coordinator at the Office of Equal Opportunity (oeo.unm.edu). For more information on the campus policy regarding sexual misconduct, see: https://policy.unm.edu/university-policies/2000/2740.html

UNM Resources:

CAPS Tutoring Services http://caps.unm.edu/programs/online-tutoring/ CAPS is a free-of-charge educational assistance program available to UNM students enrolled in classes. Online services include the Online Writing Lab, Chatting with or asking a question of a Tutor.

UNM Libraries http://library.unm.edu

Student Health and Counseling (SHAC) Online Services
http://online.unm.edu/help/learn/support/shac