SIE 452/552: Space Systems Engineering, Spring 2017
Syllabus

Course Instructor

Instructor: Prof. Roberto Furfaro, Department of Systems and Industrial Engineering, Department of Aerospace and Mechanical Engineering
Room: ENGR 305
Email: robertof@email.arizona.edu,
Tel#1: 520-621-2525
Tel#3: 520-312-7440
Office Hours: T-Th 12-4pm, T-Th 5:45-6:30pm, or By Appointment

Course Meetings

T-Th, 6:30-7:45pm, room ENGR 301 (Old Engineering Building). The lectures will be videorecorded and posted in d2l.arizona.edu

Course Description and Objectives

The main objective of the course is to introduce the fundamentals of space systems engineering to senior undergraduate and graduate science and engineering students. Designing a system for a space mission (e.g. spacecraft, smallsat, cubesat) is a complex endeavor that requires the understanding of a variety of specialized subjects (e.g. structure and mechanisms, orbital mechanics, thermal control design, telecommunications, attitude determination and control, propulsion, power systems design), but more importantly it requires an understanding of the fundamental system engineering process that must be implemented to assure that the mission goals and objectives are successfully accomplished. The course structure is conceived to provide the students with the skills and methodologies that are required to complete a preliminary design of a space system at both system and subsystem levels. Fundamentals of spacecraft subsystem design are introduced and embedded in a model-based system engineering process that will drive the preliminary design of a full-scale space system. At the beginning of the course, the students are presented with a specific space mission to be designed. The end goal is to provide a final report that presents the preliminary analysis and design of the space systems that satisfies the objectives of the mission. The lectures will provide the technical content that drives the system and subsystem design that will be accomplished throughout the semester. At the end of the course the students are expected to:

1. Master the system engineering process required to design a space mission;
2. Have a solid understanding of the principles behind spacecraft subsystem design;
3. Be able to analyze each spacecraft subsystem;
4. Be able to perform a preliminary sizing of the full space system.

Semester assignments and final project

The students will be presented with a baseline space mission, including goals and objectives as well as with top-level requirements, and are tasked with executing a full scale system and subsystem design and analysis. The goal is to incrementally progress toward a final design through application of individual system and subsystems trades and analysis. The students are required to prepare a design workbook that will be updated with multiple assignments over the course of the semester. The final grade will be computed by evaluating a set of 8 assignments that will be submitted during the semester (5% each) plus a final report (60%). Beside the baseline mission, a set of additional proposed missions involving SmallSats/CubeSats for Interplanetary Mission will be proposed. Graduate students are required to select one of such missions and develop, in addition to the subsystem analysis and design, mission-level requirements and instrument requirements. In such a case, the final report will be a complete preliminary design on the selected mission.
NOTE: The work is generally performed and submitted individually. However, for the proposed (non-baseline) missions, the final report can be submitted as team effort (no more than four (4) individuals – work done by each student shall be explicitly marked).

Grades Distribution

A regular grade (A, B, C, D, F) will be distributed to both undergraduate and graduate students. The grade will be assigned according to the following grade percentage distribution:

A: 85-100%
B: 70-84 %
C: 55-69%
D: 40-54%
F: < 40%

Class Schedule

The following class schedule is tentative and assumed to be developed over a course of 14 weeks. Special topics will provide in-depth understanding of subjects that are relevant to the specific space mission analyzed during the course of the semester.

Week 1: Introduction to Space Systems;

Week 2: System Engineering Process for a Space Mission; NASA System Engineering Process

Week 3: Fundamentals of Mission Analysis and Design

Week 4: Structure and Mechanism Subsystem Design

Week 5: Propulsion Subsystem Design

Week 6: Attitude Control Subsystem Design

Week 7: Power Subsystem Design

Week 8: Thermal Control Subsystem Design

Week 9: Command and Data Handling Subsystem Design

Week 10: Communication Subsystem Design

Week 11: Design and Analysis Progress Discussion; Special Topics I

Week 12: Design and Analysis Progress Discussion; Special Topics II

Week 13: Design and Analysis Progress Discussion; Special Topics III

Week 14: Design and Analysis Progress Discussion; Special Topics IV

Textbooks

Charles D. Brown, Elements of Spacecraft Design, AIAA Educational Series, Reston, VA : American Institute of Aeronautics and Astronautics, Inc., ©2002. (Required)

Paluszek, Michael, et. al., Spacecraft Attitude and Orbit Control, 2nd edition, Princeton Satellite Systems, 2009. (Recommended)

James R. Wertz, David F. Everett, Jeffrey J., Puschell, Space Mission Engineering: The New SMAD, Microcosm Press, 2011 (Recommended)