SIE 452/552: Space Systems Engineering, Spring 2024
Syllabus

Course Instructor

Instructor: Prof. Fabio Curti, Department of Systems, and Industrial Engineering (SIE)
Room: ENGR 314
Email: fcurti@arizona.edu
Ph#: 520-621-3331
Office Hours: Fri 2:00 – 3:00 pm (tentative) or by Appointment

Course Meetings

Mon-Wed-Fri, 11:00-11:50 am, Shantz building room 242E. The lectures will be videorecorded and posted on d2l.arizona.edu.

Course Objectives and Expected Learning Outcomes

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: orbital mechanics, attitude determination and control, space communications, thermal control, propulsion, power systems, structure and mechanisms. 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. The lectures will provide the technical content that drives the system and subsystem design that will be accomplished throughout the semester.

By taking this course, the **undergraduate** and **graduate** 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.

In addition, the **graduate students** will possess the capability to:

1. perform a preliminary design of a space system.
2. specify the requirements for a space mission performing a specified task.
3. critically evaluate choices of design and architecture.

Semester assignments and final project

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 assignments that will be submitted during the semester plus a final report. All Assignments will be submitted to D2L before the due date and time.
The project for the **undergraduate students** will be on the basic principles of a space system. The project for **graduate** students will concern the design of a space mission.

Course Breakdown

Weeks	Topics	Assignments
1	*Introduction to Space Systems* Brief history of Spacecraft; Review of spacecraft dynamics; Review of spacecraft kinematics	Assignment 1
2-3	*Fundamental of Astrodynamics* Keplerian motion; Orbital dynamics; Launch Vehicles.	
4-5	*Space Mission Analysis and Design* Interplanetary missions; Interplanetary maneuvers; Earth space environment; Orbital maneuvers; Earth missions:	Assignment 2
6	*Attitude control* Attitude dynamics; Attitude control subsystem; attitude actuators and control architectures	Assignment 3
7	*Attitude determination* Attitude sensors; Attitude estimation	
8	*Power subsystem* Primary and secondary power subsystems; Power subsystem design	Assignment 4
9	*Thermal control subsystem* Thermal environment and analysis; Thermal control technology. *Propulsion subsystems* Liquid and solid propulsion; Propulsion system architectures	
10	*Space communication subsystems* Space radio link; link budget; Signal modulation	Assignment 5
11	*On-Board Data Handling Subsystem* Telemetry, Telecommand and Coding *Mission Support from Ground Stations* Ground Station architecture; Space operations *System Engineering Process for a Space Mission* Technology readiness levels; Space project life cycle; System requirements	
12-14	Final Project	

Course Prerequisites

Advanced standing is required for **undergraduate** students. Please visit the webpage for more information on the advanced standing:
https://engineering.arizona.edu/academic-policies/advanced-standing.

For **graduate** students, knowledge of a programming language is required (e.g., MatLab). Introductory knowledge of linear algebra, differential equations and mechanics is recommended, but it is not required because the above topics will be reviewed in class.

Reading Materials

Lecture notes, provided and can be downloaded from D2L course website

Reference books:

1. Charles D. Brown, ***Elements of Spacecraft Design***, 2nd edition, AIAA Educational Series, Reston, VA, American Institute of Aeronautics and Astronautics, Inc., ©2002. ISBN-13-978-1563472626 (Required)
2. Howard D. Curtis, ***Orbital Mechanics for Engineering Students***, 3rd edition Elsevier. ISBN-13 -978-0080977478 (Recommended)
3. P. Fortescue, G. Swinerd, J. Stark, ***Spacecraft Systems Engineering,*** 4th edition, Wiley 2011, ISBN-13-978-0470750124 (Recommended)
4. ***NASA Systems Engineering Handbook***, NASA SP-2016-6105 Rev2, online (Recommended)

Grading Scale and Grade Policy

The grading scheme will follow the distribution below. University policy regarding grades and grading systems is available at http://catalog.arizona.edu/policy/grades-and-grading-system

Points	Percentage	Letter Grade
90-100	90%-100%	**A**
80-89	80%-89%	**B**
70-79	70%-79%	**C**
60-69	60%-69%	**D**
<60	<60%	**E**

Course grades for **undergraduate** section will be determined based on the following criteria:
5 Assignments (max 16 points each): 80
Final project max 20 points: : 20

Course grades for **graduate** section will be determined based on the following criteria:
5 Assignments (max 14 points each): 70
Final project max 30 points: : 30

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete and http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal respectively.

Subject to Change Statement

The information contained in the course syllabus, may be subject to change, as deemed appropriate by the instructor, see http://policy.arizona.edu/faculty-affairs-and-academics/course-syllabus-policy-undergraduate-template.