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

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<tr>
<th>Weeks</th>
<th>Topics</th>
<th>Assignments</th>
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| 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 | |
| 9     | *Thermal control subsystem*  
Thermal environment and analysis; Thermal control technology. | Assignment 4 |
|       | *Propulsion subsystems*  
Liquid and solid propulsion; Propulsion system architectures | |
| 10    | *Space communication subsystems*  
Space radio link; link budget; Signal modulation | |
| 11    | *On-Board Data Handling Subsystem*  
Telemetry, Telecommand and Coding | Assignment 5 |
|       | *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](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:**

**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](http://catalog.arizona.edu/policy/grades-and-grading-system)

<table>
<thead>
<tr>
<th>Points</th>
<th>Percentage</th>
<th>Letter Grade</th>
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<tbody>
<tr>
<td>90-100</td>
<td>90%-100%</td>
<td>A</td>
</tr>
<tr>
<td>80-89</td>
<td>80%-89%</td>
<td>B</td>
</tr>
<tr>
<td>70-79</td>
<td>70%-79%</td>
<td>C</td>
</tr>
<tr>
<td>60-69</td>
<td>60%-69%</td>
<td>D</td>
</tr>
<tr>
<td>&lt;60</td>
<td>&lt;60%</td>
<td>E</td>
</tr>
</tbody>
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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](http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete) and [http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal](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](http://policy.arizona.edu/faculty-affairs-and-academics/course-syllabus-policy-undergraduate-template).