

**San José State University**  
**Aerospace Engineering**  
**AE110 Advanced Space Systems Engineering, Fall 2019**

Instructor: Ali Guarneros-Luna  
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Class Days/Time: Mon/Wed 9:00 am – 10:15 am  
Classroom: ENG 340  
Prerequisites: Grade of “C-” or better in AE 165

### **Course Description**

Introduction to design, analysis and operation of spacecraft power, communications, attitude determination/control, structures, propulsion, thermal management systems. Typical payload systems design and operation, including remote Earth sensors. System integration issues. Lab experiments and field trips.

### **Course Goals**

1. Provide descriptions of the various elements comprising a space system.
2. Expose students to the challenge of integrating space system elements.
3. Provide an in-depth exposure to at least one spacecraft subsystem groups.
4. Educate students in the area of analysis and optimization of multidisciplinary space systems during the conceive and design phases.
5. Become familiar with the basic concepts of multi-objective optimization.

### **Course Learning Outcomes (CLO)**

Upon successful completion of this course, students will be able to:

1. Identify each element of a space system.
2. Identify each subsystem of a spacecraft.
3. Perform a systems-level analysis of spacecraft subsystems including communication, power, thermal, attitude control, structures, guidance and navigation.
4. Formulate a high-level spacecraft design given basic design parameters, involving trade-offs between competing subsystems demands.
5. Study a single spacecraft subsystem in detail within a team of 2-3 students and present their findings in class in a series of lectures.
6. Support the product development process of complex, multidisciplinary engineering systems
7. Rationalize and quantify a system architecture or product design problem by selecting appropriate objective functions, design parameters and constraints.
8. Subdivide a complex system into smaller disciplinary models, manage their interfaces and reintegrate them into an overall system model.
9. Use traditional numerical optimization algorithms.
10. Perform a critical evaluation and interpretation of analysis and optimization results, including sensitivity analysis and exploration of performance, cost and risk tradeoffs.
11. Develop and codify a prescriptive approach to multidisciplinary modeling and quantitative assessment of new or existing system/product architectures

## Required Texts/Readings

### Textbook

Sellers, J. J., Astore, W. J., Giffen, R. B., & Larson W. J. (2005). *Understanding Space: An Introduction to Astronautics*. 3<sup>rd</sup> ed., Space Technology Series. New York, NY: McGraw-Hill Education.

### References

Pisacane, V. L. & Moore, R. C. (1994). *Fundamentals of Space Systems*. Oxford, UK: Oxford Press.

## Course Requirements and Assignments

### Week Topic(s)

- 1 Introduction, Course Overview, Mission Analysis and Design
- 2 Space System characterization:
  - i. Identification of objectives, design variables, constraints, subsystems
  - ii. System-level coupling and interactions
- 3 Subsystem model development:
  - i. Model partitioning, interface control
  - ii. Subsystem model selection: fidelity versus expense
- 4 Space system design optimization and exploration techniques:
  - i. Review of linear and nonlinear programming
  - ii. Design Space Exploration: Design of Experiments (DOE)
- 5 Design sensitivity analysis, trade-off studies and approximations
- 6 Multi-objective system level optimization, spacecraft design and sizing
- 7 Launch vehicles and space environment Subsystem presentations:
- 7 Communications, Command and Data Handling
- 8 Power
- 9 Thermal
- 10 Propulsion
- 11 Attitude Dynamics and Control
- 12 Structures
- 13 Guidance, Navigation, and Control
- 14 Mission Operations, Spacecraft Integration

## Miscellaneous Topics, Summary, Review Grading Information

Homework	300 points
1 <sup>st</sup> Midterm	350 points
Final Project	350 points

## Determination of Grades

<i>Grade</i>	<i>Points</i>
<i>A plus</i>	<i>950 to 1000</i>
<i>A</i>	<i>900 to 949</i>
<i>A minus</i>	<i>850 to 899</i>
<i>B plus</i>	<i>775 to 849</i>
<i>B</i>	<i>725 to 774</i>

<i>Grade</i>	<i>Points</i>
<i>B minus</i>	<i>700 to 724</i>
<i>C plus</i>	<i>675 to 699</i>
<i>C</i>	<i>625 to 674</i>
<i>C minus</i>	<i>600 to 624</i>
<i>D</i>	<i>500 to 599</i>
<i>F</i>	<i>499 and below</i>

### **University Policies**

Per [University Policy S16-9](http://www.sjsu.edu/senate/docs/S16-9.pdf) (<http://www.sjsu.edu/senate/docs/S16-9.pdf>), relevant information to all courses, such as academic integrity, accommodations, dropping and adding, consent for recording of class, etc. is available on Office of Graduate and Undergraduate Programs' [Syllabus Information web page](http://www.sjsu.edu/gup/syllabusinfo/) at <http://www.sjsu.edu/gup/syllabusinfo/>.

# AE 110 / Space Systems Engineering, Semester, Course Schedule

## Course Schedule

Week	Topics
1	Introduction, Course Overview, Mission Analysis, and Design
2	Space System characterization: i. Identification of objectives, design variables, constraints, subsystems ii. System-level coupling and interactions
3	Subsystem model development: i. Model partitioning, interface control ii. Subsystem model selection: fidelity versus expense
4	Space system design optimization and exploration techniques: i. Review of linear and nonlinear programming ii. Design Space Exploration: Design of Experiments (DOE)
5	Design sensitivity analysis, trade-off studies and approximations
6	Multi-objective system level optimization, spacecraft design and sizing
7	Launch vehicles and space environment Subsystem presentations: Communications, Command and Data Handling
8	Power
9	Thermal
10	Propulsion
11	Attitude Dynamics and Control
12	Structures
13	Guidance, Navigation, and Control
14	Mission Operations, Spacecraft Integration
15	Miscellaneous Topics, Summary, and Review