Instructor: Ali Guarneros-Luna

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Class Days/Time: Mon/Wed 9:00 am – 10:15 am

Aug 19, 2020-Dec 7, 2020

Classroom: ENG 340/ Virtual

Prerequisites: Grade of “C-” or better in AE 165

# Space Systems Engineering

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 trip when ever possible.

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

**Textbook**

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

**References**

1. 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 |

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| 2 | Space System characterization:<br>i. Identification of objectives, design variables, constraints, subsystems<br>ii. System-level coupling and interactions |
| 3 | Subsystem model development:<br>i. Model partitioning, interface control<br>ii. Subsystem model selection: fidelity versus expense |
| 4 | Space system design optimization and exploration techniques:<br>i. Review of linear and nonlinear programming<br>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 |
| 8 | Communications, Command and Data Handling |
| 9 | Power |
| 10 | Thermal |
| 11 | Propulsion |
| 12 | Attitude Dynamics and Control |
| 13 | Structures |
| 14 | Guidance, Navigation, and Control &Mission Operations, Spacecraft Integration |

## Miscellaneous Topics, Summary, Review Grading Information

Homework 300 points

1st Midterm 350 points

Final Project 350 points

## AE110 Aerospace Engineering Rubric

| % of points | Advanced 100% to 80% | Proficient 80% to 60% | Basic 60% to 50% | Below Basic low than 50% |
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| Content | Homework/project/ paper contains relevant information. Content is based on information in the text. Content includes additional detailed information found in further researching the topic. Content presents advanced material that goes beyond the requirements for the project. | Homework/project/ paper contains relevant information. Content is based on information in the text. Content includes additional detailed information found in further researching the topic. | Homework/project/ paper contains minimal information relevant to topic. Topic is slightly discussed but more material is needed. Content does not include additional information found in further research. | Homework/proje paper does not contain relevant information. |
| Graphics/Use of Media | Text is legible. No grammatical errors. Graphics and effects are used appropriately throughout to enhance presentation. Information is at the advanced level and consistently supports images. Uses other technology to enhance presentation materials. | Text is legible. No grammatical errors. Appropriate use graphics and effects to enhance presentation. Information adequately supports images. | The amount of text is inappropriate for the space provided. Some grammatical errors. Some attempt to offer appropriate graphics or effects. Information supports images at times. Minimal use of media. | The Graphics is not legible. The amount of text is inappropriate for the space provided. There are several grammatical errors. There is little use of graphics or effects. The information does not consistently support images. No evidence of media used to enhance the materials of slide |
| Presentation/Organization | The presentation | The presentation | The presenters | The presenters |

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| | is well coordinated. All material is presented using language that is original. Speaker is well informed and elaborates beyond the displayed material. Speaker does NOT read off of slides or notes. | is well coordinated. Most material is presented in new form and not as it is written on the screen. Speaker does NOT read off of slides or notes. | make minimal eye contact with the audience. Everything is read directly from the screen or page. | make no contact with the audienc Everything is rea directly from the screen of page. |
| Knowledge | when talking about Homework/project/ paper, Speaker is well informed and elaborates beyond the displayed material. | when talking about Homework/project/ paper, Speaker is well informed and elaborates a bit beyond the material displayed. | when talking about Homework/project/ paper, Speaker brings little knowledge to the presentation beyond what is displayed | when talking abo Homework/proje paper, Speaker simply reads the material displaye |
| Involvment of Class | Presentation thoroughly involves class through group presentation of materials and/or activities AND holds the attention of the class throughout delivery of topic content. | Some class involvement AND some maintenance of class attention through topic presentation. | Minimal class involvement AND minimal maintenance of attention for duration of presentation. | Presentation doe not involve class in any capacity r maintain their attention. |
| Voice/Delivery | when talking about Homework/project/ paper, Speaker presents in a loud | when talking about Homework/project/ paper, Speaker presents in a loud | when talking about Homework/project/ paper, Speakers presents in a voice | when talking abo Homework/proje paper, Speaker does not presen |

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| | and clear voice and does not read from screen or notes. | and clear voice but constantly turns to the screen. | that is sometimes clear but constantly turns to the presentation. | in a loud or clear voice and reads simply from the presentation. |
| Time Usage | Presentation proceeds at a comfortable pace. Presenter pauses for questions or clarification. | Presenter moves through presentation somewhat briskly. Allows minimal questions or comments. | Presenter hurries through presentation with little regard for audience participation. | Presentation is fast and no interaction with audience. |