ASTE 421 Mission Systems Design

Units: 3.0

Spring 2022—Tuesday and Thursday—3:30-4:50pm

IMPORTANT:

The general formula for contact hours is as follows:
Courses must meet for a minimum of one 50-minute session per unit per week over a 15-week semester. Standard fall and spring sessions (001) require a final summative experience during the University scheduled final exam day and time.

Location: VHE 217

Instructor: Prof. Dave Barnhart
Office: None
Office Hours: Thursdays from 0900-11:30am, RRB201
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Instructor: Dr. Lisa Hill
Office: None
Office Hours: TBD
Contact Info: lisa.hill@usc.edu; 310-567-7651

Teaching Assistant: Soon

Course Description

Capstone, team-oriented space systems design course that will introduce the students to the techniques for completing a credible design solution and producing an effective written design report and presentation that could be delivered to an engineering review team or customer.

Student-led teams of 5-20 students, depending on total course enrollment and project definition, will design, analyze, and defend a space system design solution to an instructor-provided mission problem. The team design problem will be different each year and based on current topics of interest in the industry.

Learning Objectives

The objective of this course is to introduce the students to the techniques for developing and defending a credible mission design solution and for producing an effective written design report that could be delivered to an engineering review team or customer.

An emphasis is placed on the following topics: successful design team group operation, mission and design engineering process, requirements definition, space system design fundamentals, trade space definition, technical reviews, cost and schedule development, risk identification and assessment, econometric analysis and ethics.

Upon successful completion of this course, students will be able to: (a) develop a plan and schedule for a design project; (b) develop a credible space systems technical concept based on the stated mission need; (c) develop spacecraft design which includes evaluation of space subsystems and structures; (d) produce cost, schedule and risk estimates and econometric analysis, (e) document his/her work through oral presentations and a formal, written final design document, and (f) work effectively in an integrated team design environment.

Prerequisite(s): ASTE 330, Astronautics and Space Environment II.
Co-Requisite(s): None
Concurrent Enrollment: None
Recommended Preparation: None

Course Notes

Course notes, references, and other class items will be placed on Blackboard.

Readings and Supplementary Materials

1. Wertz, James, R. and Larson, Wiley J., editors, Space Mission Analysis & Design, 3rd edition, Kluwer Academic Publishers, 1999. ISBN 978-1881883-10-4.
2. NASA Systems Engineering Handbook, SP-610S (provided in Blackboard)
3. Space Vehicle Design, Second Edition (AIAA Education) by Michael D. Griffin, James R. French
4. Elements of Spacecraft Design (AIAA Education) by Charles D. Brown
5. Spacecraft Systems Engineering 3rd Edition by Peter Fortescue (Editor), John Stark (Editor), Graham Swinerd (Editor).

General Description of Assignments

This course is approximately 20% lecture format, 30% individual work, and 50% team collaboration in design reports and presentations. Student teams will be typically formed using 5-10 students, with the number aof students and makeup of the group(s) at the discretion of the instructor. Students are responsible for reading any assigned material prior to the scheduled class and bringing the books/tools needed to work with the group. Class attendance and participation is required and part of the course grading. Students are encouraged to actively participate in both lecture and group activities and to ask questions freely. Students will be expected to present as an indivual or as part of the team any design progress during the semester and then the completed work at the end.

Assignments:

Class Attendance:

Design is a team sport, and therefore attendance is required at every class and meeting and counts toward your final grade. A late arrival, arriving more than 15 minutes late to class, counts as half an absence. You will notify the instructor(s) at least a day in advanceif you need to be excused from class for a known conflict or issue, and if excused, this absence does not count against your grade. You must also notify your team leader/team of your absence and work to make up or support any activities you missed. If you are ill the day of class you must notify your team lead and text or e-mail Dr. Hill and/or Prof. Barnhart before class begins on the day of class to be excused.

Individual Work Reports:

Each student will present a summary of the student's work based on the defined schedule in this syllabus and delivered electronically into Blackboard by the time specified. Additional material, such as analysis, diagrams, code, etc. can be attached if it is the original work of the student and is only used to support the work or provide backup proof. Do not attach the work of another student, unless noted that this was in collaboration with this other student. The instructors would expect the other student would also report this collaboration. The format and typical structure of this report will be provided in class and on Blackboard.

Project Definition Review and Business Plan Concept - Presentation:

The Project Definition Review represents your understanding of the project focus, functional requirements, project scope, and deliverables. It a document that will include the following elements: problem description, context of this work with respect to other activities in the area, specific project objective, functional requirements, critical elements of the design, a first concept of operations, first idea of business plan and a team description The document will be delivered and presented by the team in an approved format (Word,pdf, etc), reviewed by the instructors. More specifics on this review will be provided in class and on Blackboard, and can vary some from semester to semester.

Conceptual Design Review and Business Plan Update- Presentation:

The Conceptual Design Review presents your concept design requirements, trade space options and process, and a description a baseline system design solutions that will be further detailed before the final review. The Review will be presented in summary to the instructors and any invited guests, lasting approximately 30-55 minutes per team, based on the number of teams. Expected elements of this report include functional requirements and flowdown to systems elements, trade space definition, trade space process and selections, a baseline system design that includes space, ground, and launch and the foundation of the business plan. Members of the space community may be part of the audience for this presentation, in person or via webcast. More specifics on this review will be provided in class and on Blackboard, and can vary some from semester to semester.

Final Design and Business Plan Review – Presentation:

The final presentation will be scheduled to allow for 45-60 minutes for each team (depending on the number of teams/students) to give a stand-up presentation of the final design and business plan. Members of the space community are typically part of the audience for this final presentation, either in person or via webcast. This presentation serves as the final exam and therefore occurs during the final exam time, but adjustments to the start and end time may occur to allow for eqch teams to present the work. Specific details on this review will be provided in class and on Blackboard, as it varies with design problem.

Final Design and Business Plan -Final Report:
The final report is a delivered document in an appropriate format (Word, pdf, etc) that is the culmination of the semester's work and addresses all aspects of the completed design solution for this project. The report is typically 70-100+ pages, with additional appendix attachments for numerical analyses, detailed design trades, and other documents that support the design solution or a student(s) grade. This report is typically delivered the final week of class. Specific details on this document with examples will be provided in class and on Blackboard, as the document can vary with the particular design problem. Each student is solely responsible for his/her part of the final report and the document shall be annotated accordingly.

Peer Review(s):
Periodically throughout the semester, typically in conjunction with reviews and report assignments listed above, each student will be asked to assess each team member's work and participation within the team. A specific format for this assessment will be provided and instructions given on hoew to complete it. This peer review is an integral part of the design team operations and is required in order to complete any assignment where it is included. The individual work report will link to this peer review.

Grading Breakdown

The course grade will be based upon both individual and team efforts of each student based on the percentages assigned below. A time and date for each report or presentation will be provided separately, as well as minimum topics required, and absolutely no late reports will be accepted.
All deliveries of reports or presentations will be entirely electronic, with details provided in class.

Assignment	Points	% of Grade
Class Attendance	100	10
Individual Status Reports	150	15
Project Definition Document	150	15
Conceptual Design Document and Review	250	25
Final Design Report	250	25
Final Exam Presentation	100	10
TOTAL	1000	100

Grading Scale (Typical)

Course final grades will be determined using the following scale:

A	92-100
A-	88-91
B+	85-87
B	81-84
B-	78-80
C+	75-77
C	71-74
C-	68-70
D+	65-67
D	61-66
D-	58-60
F	58 and below

Assignment Submission Policy

Assignments will be submitted electronically, as defined for each in class and on Blackboard.

Additional Policies and Comments

This course is driven by students and the teams, and as such, class will have limited lectures that serve to augment your prior astronautics education (e.g, mission design, risk definition and assessment, etc). The instructors will serve to provide sage advice and guidance rather than as lecturers. This is your opportunity to use what you have learned and expand upon it and learn new things. The answer to the class problem is not found in a book nor is it provided by the instructors but must be developed and defended by you and your teammates.

1. In excess of 2.5 hours per week are spent in class. This time is valuable to your work as a team and each student is expected to attend every class and to be available for group meetings outside of class.

2. Each student will be given advice and guidelines for future presentations in class. The class, instructors, and teaching assistant will participate in this process.

3. Design is an interactive process in which one part of the design can and does influence more or all the other parts. Your design effort must reflect this interaction. To be successful you must be able to collaborate with each other.

4. All numerical results shall be supported by quantitative analysis (verified) aas mch as possible and not just a qualitative assessment.

5. Due to the nature of the problem, some analyses will be highly detailed and others, will be necessarily superficial but based on reference or model. Topics that will be covered in some detail include orbital mechanics and trajectory design, attitude determination and control, telecommunications, thermal control, power generation and storage, propulsion, structures and materials. Less detail may show up in risk assessment and cost and business analysis and system level design trades.

6. Some issues in the design may come up that are beyond the scope of the project or time available to assess. These types of issues will be identified and described and noted as something for future work. These items may be decided by the instructor in real time as the design process evolves.

7. A Project Manager (PM) will be elected by the team by the end of the first week. This PM, or a designee of the PM, will be responsible for coordinating team activities and schedules, delivery of team assignments, all while and also making a cogent technical contribution to the project design. The PM can assign (or accept as volunteer) another team member to be the Assistant PM.

8. Each student will support at least one discipline for this design process, and the discipline may shift over the course of the semester. Disciplines include but are not limited to: mission systems - launch, trajectories, deltaV, requirements flowdown, concept of operations, ground system, user metrics/system metrics, risk identification and analysis, cost assessment and business plans, as well as spacecraft systems and subsystems– attitude control, power, thermal, propulsion, structures, communication, spacecraft systems - architecture trades, payload/data systems, spacecraft mass and power budgets, configuration control, etc.

9. A team name and a written, signed rules of engagement will be completed by the beginning of the second week and submitted to Blackboard. The rules of engagement are the rules by which you, as team members will follow, which includes how to make decisions, expectations of behavior, meeting times, etc.

11. References are critical to the final report document, and as such, you should compile and keep a list of references and specific attributes from the beginning of your research into the problem.

Course Schedule:

Schedule and course content may be altered if needed due to the specific project and problems that arise by teams as part of the design process. The primary schedule for this class centers on the milestone reviews and document deliveries. Lectures and in-class discussions are intended to provide direction on and examples that meet the milestones, which can include special topics unique to the specific mission.

		Topics/Daily Activities	**Deliverable**
Week 1	Jan 11, 13	Project General Discussion; Student Introductions; Class Organization	--
Week 2	Jan 18, 20	Mission Engineering Products; Project Documents; Business Plans	--
Week 3	Jan 25, 27	Systems Engineering Requirements	--
Week 4	Feb 1, 3	Team Activities	**Project Definition Review**
Week 5	Feb 8, 10	Systems Engineering Trades	Individual Status
Week 6	Feb 15, 17	Risk Process; Cost Assessment	--
Week 7	Feb 22, 24	Team Activities	--
Week 8	Mar 1, 3	Team Activities	**--**
Week 9	Mar 8, 10	Space Vehicle Design; Detailed Design process	**Concept Design Review**
Week 10	Mar 15, 17	BREAK	--
Week 11	Mar 22, 24	Team Activities	--
Week 12	Mar 29, 31	Team Activities	--
Week 13	Apr 5, 7	Team Activities	--
Week 14	Apr 12, 14	22 – Wellness Day Team Activities	Individual Status
Week 15	Apr 19, 21	Team Activities	**---**
Week 16	Apr 26, 28	Team Activities	**Final Report**
FINAL	May 10(TBC)		**Final Review Presentation**

Statement on Academic Conduct and Support Systems

Academic Conduct:

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, "Behavior Violating University Standards" policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct.

Support Systems:

Student Counseling Services (SCS) – (213) 740-7711 – 24/7 on call
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. engemannshc.usc.edu/counseling

National Suicide Prevention Lifeline – 1 (800) 273-8255
Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. www.suicidepreventionlifeline.org

Relationship and Sexual Violence Prevention Services (RSVP) – (213) 740-4900 – 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender-based harm. engemannshc.usc.edu/rsvp

Sexual Assault Resource Center
For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: sarc.usc.edu

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086
Works with faculty, staff, visitors, applicants, and students around issues of protected class. equity.usc.edu

Bias Assessment Response and Support
Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. studentaffairs.usc.edu/bias-assessment-response-support

The Office of Disability Services and Programs
Provides certification for students with disabilities and helps arrange relevant accommodations. dsp.usc.edu

Student Support and Advocacy – (213) 821-4710
Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. studentaffairs.usc.edu/ssa

Diversity at USC
Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. diversity.usc.edu

USC Emergency Information
Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible. emergency.usc.edu

USC Department of Public Safety – UPC: (213) 740-4321 – HSC: (323) 442-1000 – 24-hour emergency or to report a crime.

Provides overall safety to USC community. dps.usc.edu