rev 8/19/2025

ASEN 5158
SPACE HABITAT DESIGN

Fall 2025
Tuesday/Thursday 10:00-11:15am
Room: AERO 114

Instructor: Dr. Torin Clark
email: torin.clark@colorado.edu
office hours: TBD, AERO N301

Zoom: Join URL: TBD

Course TA: Amrita Singh
email: amrita.singh@colorado.edu
office hours: attending some group project meetings

Classroom Recordings:
Available via Canvas under Lecture Videos
Zoom: https://cuboulder.zoom.us/j/95061100571

We will use Canvas' Discussions board for online discussions related to the technical material of the course. I ask that you post your questions related to course material there, such that other students can review and answer, as well as the instruction team. It is likely that your question may also be a question that other students are having, so posting to Canvas will facilitate availability to everyone. If you have non-technical questions that only relate to yourself you may email myself and our TA (as appropriate) with the subject line "ASEN 5158: ___".

Course Objectives

Utilize systems engineering methods to design and analyze a spacecraft intended for human occupancy with functional knowledge of the technologies used to sustain life. Emphasis placed on deriving requirements from stated mission goals and objectives, developing integrated functional schematics into a conceptual design, and analyzing design options by mass/volume estimation, including launch vehicle selection.

Office Hours

TBD, will be set after first week of class

Text –either eBook or Print, your choice, this is a nice keeper reference with lots of useful design info

Human Spaceflight Mission Analysis and Design, Larson, McQuade and Pranke (2nd ed.)
https://spacetechnologyseries.com/books/Human-Spaceflight.html

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Topics (*contents and sequence subject to minor revision during the semester*)

Introduction to Human Spaceflight
Human Space Mission Objectives
Space Environments – Orbit, Planets and NEO's
Human Physiology
Ergonomics, Human Factors and Psychology

Systems Engineering Terminology, Definitions, Acronyms and Design Phases
Deriving Requirements and Constraints from Mission Goals and Ground Rules and Assumptions
Concept of Operations (ConOps), Design Reference Mission (DRM), Operational Concept (OpsCon)

Orbit Selection
Entry / Descent/ Landing / Ascent

Functional Decomposition
- Minimum Functionality Design Approach – *Physics & Physiology*
- Trade Space Cost-Benefit Analysis Philosophy – *Safety & Operability*

Defining and Sizing Spacecraft Elements
- Human-Rating Process – *Accommodate, Utilize and Protect*
- 'Human in the Loop' Design Drivers – *Alive, Healthy, Happy and Productive*
- Determining Habitable Volume and Atmospheric Composition

Environmental Control & Life Support System (ECLSS) Functions & Enabling Technologies
- Atmosphere Management, Water Management, Food Supply, Waste Processing

Crew and Payload Accommodations (CA / PA)
Spacesuits and Extravehicular Activity Systems (EVAS)

Functions, Integration and Interfaces ***summarized*** for the following remaining spacecraft subsystems
- Command, Control and Communication (C3)
- Attitude Determination & Control System (ADCS) / Guidance Navigation & Control (GNC)
- Electrical Power Distribution System (EPDS)
- Active Thermal Control System (ATCS)
- *in situ* Resource Utilization (ISRU)
- Structures & Mechanisms
- Spacecraft Propulsion
- Launch Vehicles / Orbital Transfer Systems

Risk Management Considerations
- Hazard Analysis / Failure Mode Effects Analysis (FMEA) / Probabilistic Risk Assessment (PRA)
- Risk Mitigation Strategies (redundancy, reliability, robustness, FOS, margins, DFMR, etc.)
- Overview of Verification & Validation (V&V) / Manufacturability / Test / Operations

Final ~ *Group Project Reports due and Final Presentations given on Monday, Dec. 8, 1:30–4 p.m.*

Homework (10%), **6 Quizzes** (lowest score will be dropped, 10% for each of remaining 5), **Group Project** (40% *with individual weightings as warranted*)

Distance students, along with in-person students will take Quizzes via Canvas over a 1 week period. All other assignments (homework and group project deliverables) are due per the normal schedule. Lecture notes and recordings will be posted on Canvas shortly after each class. I will offer a zoom link if you would like to attend lecture remotely by synchronously.

Group design project participation requires regular attendance (in person or remote) at a weekly working meeting for 1-2 hours. Teaming arrangements will be made in the second week of class. Meeting time slot options will include **Sunday evening and Monday throughout the day/evening** to

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accommodate class and work schedules to the extent possible, such that all meetings take place before discussions in class on Tuesdays. Projects are set up for a mix of local and remote students to participate on each team.

Unexcused late submittals will be penalized a minimum of 10% with up to 2% per day lost for each additional day. **This includes late contributions to group submittals** (*individual penalty, not group*).

Missed presentations will not be made up unless arrangements are made at least one week in advance of the due date. Unexpected emergencies (e.g., medical, family, etc.) and other events (e.g., work-related travel, jury duty, etc.) will be addressed on a case-by-case basis, vacations are not excused.

Please note that I get a lot of emails, so to ensure a timely response, be sure to indicate 'ASEN 5158' in the subject line with some indication of topic (do not just hit 'reply' to an unrelated email from me).

Please inform me of any classroom or exam accommodations needed at the beginning of the semester or as circumstances warrant later so we can plan accordingly (*see additional info below*).

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Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the Honor Code may include but are not limited to: plagiarism (including use of paper writing services or technology [such as essay bots]), cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. Understanding the course's syllabus is a vital part of adhering to the Honor Code. All incidents of academic misconduct will be reported to Student Conduct & Conflict Resolution: StudentConduct@colorado.edu. Students found responsible for violating the Honor Code will be assigned resolution outcomes from Student Conduct & Conflict Resolution and will be subject to academic sanctions from the faculty member. Visit Honor Code for more information on the academic integrity policy.

Accommodation for Disabilities, Temporary Medical Conditions, and Medical Isolation

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the Disability Services website. Contact Disability Services at 303-492-8671 or DSinfo@colorado.edu for further assistance. If you have a temporary medical condition, see Temporary Medical Conditions on the Disability Services website.

If you have a temporary illness, injury or required medical isolation for which you require adjustment, please notify Prof. Clark and your TA. You do not need a doctor's note or to state the nature of your illness, just how it will impact your participation in the class. Note that quizzes can be taken online over a week long period.

Accommodation for Religious Obligations

Campus policy requires faculty to provide reasonable accommodations for students who, because of religious obligations, have conflicts with scheduled exams, assignments, or required attendance. Please communicate the need for a religious accommodation in a timely manner. In this class, please contact Prof. Clark and your TA to coordinate if religious observances conflict with completing course deliverables (e.g., quizzes or group projects). See the campus policy regarding religious observances for full details.

Preferred Student Names and Pronouns

CU Boulder recognizes that students' legal information does not always align with how they identify. If you wish to have your preferred name (rather than your legal name) and/or your preferred pronouns appear on your instructors' class rosters and in Canvas, visit the Registrar's website for instructions on how to change your personal information in university systems.

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Classroom Behavior

Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote, or online. Failure to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, marital status, political affiliation, or political philosophy.

Additional classroom behavior information

- Student Classroom and Course-Related Behavior Policy.
- Student Code of Conduct.
- Office of Institutional Equity and Compliance.
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Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. University policy prohibits protected-class discrimination and harassment, sexual misconduct (harassment, exploitation, and assault), intimate partner abuse (dating or domestic violence), stalking, and related retaliation by or against members of our community on- and off-campus. The Office of Institutional Equity and Compliance (OIEC) addresses these concerns, and individuals who have been subjected to misconduct can contact OIEC at 303-492-2127 or email OIEC@colorado.edu. Information about university policies, reporting options, and OIEC support resources including confidential services can be found on the OIEC website.
Please know that faculty and graduate instructors are required to inform OIEC when they are made aware of incidents related to these concerns regardless of when or where something occurred. This is to ensure the person impacted receives outreach from OIEC about resolution options and support resources. To learn more about reporting and support a variety of concerns, visit the Don't Ignore It page.

Mental Health and Wellness

The University of Colorado Boulder is committed to the well-being of all students. If you are struggling with personal stressors, mental health or substance use concerns that are impacting academic or daily life, please contact Counseling and Psychiatric Services (CAPS), located in C4C, or call (303) 492-2277, 24/7.

Acceptable Use of AI in This Class

Generative artificial intelligence tools—software that reproduces text, images, computer code, audio, video, and other content—have become widely available. Well-known examples include ChatGPT for text and DALL•E for images. This statement governs all such tools, including those released during our semester together. Keep in mind that the goal of gen AI tools is to reproduce content that seems to have been produced by a human, not to produce accurate or reliable content; therefore, relying on a gen AI tool may result in your submission of inaccurate content. It is your responsibility—not the tool's—to assure the quality, integrity, and accuracy of work you submit in any college course.

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In preparation of your homework assignments and project deliverables you may use generative AI tools to identify resources, summarize sources for your review, help craft initial drafts or refine text. This may help you expedite reviewing many sources and narrowing down which require more careful review. However, as is the case for engineers and researchers in the field, you are responsible for the content that you submit and should have a firm understanding of not just the material that you submit, but also the materials upon which it is based. To assess this, we will perform brief oral interviews regarding your homework submissions and their related topics.

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