

# ASEN 5158 SPACE HABITAT DESIGN

Fall 2022  
Tuesday/Thursday 10:00-11:15  
Room Aero N240

*Lecture notes and recordings will be available on Canvas shortly after class*

**Instructor: Prof. David Klaus**

email: [klaus@colorado.edu](mailto:klaus@colorado.edu)

telephone: (303) 492-3525

**TA: Sam Kurtin**

email: [Samuel.Kurtin@colorado.edu](mailto:Samuel.Kurtin@colorado.edu)

---

## 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

---

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

*Human Spaceflight Mission Analysis and Design*, Larson, McQuade and Pranke (2<sup>nd</sup> ed.)

<https://spacetechnologyseries.com/books/Human-Spaceflight.html>

---

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

## **Exam 1 ~ Requirement Drivers**

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

- 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)

## Exam 2 ~ *Design Process*

Functions, Integration and Interfaces summarized for the following remaining spacecraft subsystems

Structures & Mechanisms

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)

Spacecraft Propulsion

Launch / Transfer Systems

## Risk Management

Hazard Identification and Analysis

Failure Mode Effects Analysis (FMEA) / Probabilistic Risk Assessment (PRA)

Risk Mitigation Strategies (redundancy, reliability, robustness, FOS, margins, DFMR, etc.)

Verification & Validation (V&V) / Manufacturability / Test / Operations

**Final** ~ *Group Project Reports due and Final Presentations given on Saturday, Dec. 10, 1:30–4 p.m.*

---

## Grading

**20% for Homework, Quizzes & Participation, 40% from 2 Exams** (20% each), **40% from Group Project** (with individual weighting as warranted). **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 quizzes/exams/presentations** will not be made up unless acceptable arrangements are made at least one week in advance of due date - documented emergencies (medical, jury duty, etc.) excepted, other events considered on a case-by-case basis (work-related travel), but vacations, including early departure prior to fall and winter break, not allowed).

## Emails

Please note that I get a lot of email, so to ensure a timely response, be sure to indicate ‘ASEN 5158’ in the subject line.

---

## CLASSROOM BEHAVIOR

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail 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, political affiliation or political philosophy. For more information, see the [classroom behavior](#) policy, the [Student Code of Conduct](#), and the [Office of Institutional Equity and Compliance](#).

## REQUIREMENTS FOR COVID-19

As a matter of public health and safety, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements and all public health orders in place to reduce the risk of spreading infectious disease. CU Boulder currently requires COVID-19 vaccination and boosters for all faculty, staff and students. Students, faculty and staff must upload proof of vaccination and boosters or file for an exemption based on medical, ethical or moral grounds through the MyCUHealth portal.

The CU Boulder campus is currently mask-optional. However, if public health conditions change and masks are again required in classrooms, students who fail to adhere to masking requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to Student Conduct and Conflict Resolution. For more information, see the policy on classroom behavior and the Student Code of Conduct. If you require accommodation because a disability prevents you from fulfilling these safety measures, please follow the steps in the “Accommodation for Disabilities” statement on this syllabus.

If you feel ill and think you might have COVID-19, if you have tested positive for COVID-19, or if you are unvaccinated or partially vaccinated and have been in close contact with someone who has COVID-19, you should stay home and follow the further guidance of the Public Health Office ([contacttracing@colorado.edu](mailto:contacttracing@colorado.edu)). If you are fully vaccinated and have been in close contact with someone who has COVID-19, you do not need to stay home; rather, you should self-monitor for symptoms and follow the further guidance of the Public Health Office ([contacttracing@colorado.edu](mailto:contacttracing@colorado.edu)). Please communicate any illness issues or concerns you have to me.

## ACCOMMODATION FOR DISABILITIES

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](mailto:dsinfo@colorado.edu) for further assistance. If you have a temporary medical condition, see [Temporary Medical Conditions](#) on the Disability Services website.

## PREFERRED STUDENT NAMES AND PRONOUNS

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

## 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, 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. All incidents of academic misconduct will be reported to Student Conduct & Conflict Resolution ([honor@colorado.edu](mailto:honor@colorado.edu)); 303-492-5550). Students found responsible for violating the [Honor Code](#) will be assigned resolution outcomes from the Student Conduct & Conflict Resolution as well as be subject to academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found on the [Honor Code website](#).

## 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 sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, protected-class discrimination and harassment, and related retaliation by or against members of our community on- and off-campus. These behaviors harm individuals and our community. The Office of Institutional Equity and Compliance (OIEC) addresses these policies, and individuals who believe they have been subjected to misconduct can contact OIEC at 303-492-2127 or email [cureport@colorado.edu](mailto:cureport@colorado.edu). Information about university policies, [reporting options](#), and support resources can be found on the [OIEC website](#).

Please know that faculty and graduate instructors have a responsibility to inform OIEC when they are made aware of any issues related to these policies regardless of when or where they occurred to ensure that individuals impacted receive information about their rights, support resources, and resolution options. To learn more about reporting and support options for a variety of concerns, visit [Don't Ignore It](#).

## RELIGIOUS HOLIDAYS

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, please notify me at least one week in advance of any conflicts and we will determine alternate arrangements.

See the [campus policy regarding religious observances](#) for full details.