

ASEN 5158 SPACE HABITAT DESIGN

Fall 2023
Tuesday/Thursday 10:00-11:15
Room Aero 114

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

Instructor: Prof. David Klaus
email: klaus@colorado.edu

TA: Luca Bonarrigo
email: Luca.Bonarrigo@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 based on poll of best times

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 (2nd 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
- 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)

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 Vehicles / Orbital Transfer Systems

Risk Management Considerations
Hazard Identification and 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 Saturday, Dec. 16, 1:30–4 p.m.*

Grading

Homework (10%), **2 Exams** (25% each), **Group Project** (40% *with individual weightings as warranted*)

Distance students are required to arrange a proctor for the two exams and have up to one week after the in-class period to complete them. Details on this process will be provided. All other assignments (homework and group project deliverables) are due per the normal schedule.

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 exams/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, but vacations, including early departure prior to fall and winter break, are not excused.

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 with some indication of topic (do not just hit ‘reply’ to an unrelated email from me).

Campus Policies and Guidelines

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, 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 INFECTIOUS DISEASES

Members of the CU Boulder community and visitors to campus must follow university, department, and building health and safety requirements and all public health orders to reduce the risk of spreading infectious diseases.

The CU Boulder campus is currently mask optional. However, if masks are again required in classrooms, students who fail to adhere to masking requirements will be asked to leave class. Students who do not leave class when asked or who refuse to comply with these requirements will be referred to Student Conduct & Conflict Resolution. Students who require accommodation because a disability prevents them from fulfilling safety measures related to infectious disease will be asked to follow the steps in the “Accommodation for Disabilities” statement on this syllabus.

For those who feel ill and think you might have COVID-19 or if you have tested positive for COVID-19, please stay home and follow the [further guidance of the Public Health Office](#). For those who have been in close contact with someone who has COVID-19 but do not have any symptoms and have not tested positive for COVID-19, you do not need to stay home.

Accommodation for Disabilities, Temporary Medical Conditions, and Medical Isolation

[Disability Services](#) determines accommodations based on documented disabilities in the academic environment. If you qualify for accommodations because of a disability, submit your accommodation letter from Disability Services to your faculty member in a timely manner so your needs can be addressed. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance.

If you have a temporary medical condition or required medical isolation for which you require accommodation, please reach out to me in a timely manner to make arrangements. You are not required to divulge details. Also 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 (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.

All incidents of academic misconduct will be reported to Student Conduct & Conflict Resolution: 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. Visit [Honor Code](#) for more information on the academic integrity policy.

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 violence (dating or domestic violence), stalking, 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 concerns, and individuals who believe they have been subjected to misconduct can contact OIEC at 303-492-2127 or email 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 incidents related to these policies regardless of when or where something occurred. This is to ensure that individuals impacted receive an outreach from OIEC about their options for addressing a concern and the support resources available. To learn more about reporting and support resources for a variety of issues, 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 reach out to me in advance to make arrangements.

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

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.

Free and unlimited telehealth is also available through [Academic Live Care](#). The Academic Live Care site also provides information about additional wellness services on campus that are available to students.