

# ASEN 5158 SPACE HABITAT DESIGN

Fall 2019  
Tuesday/Thursday 2:30-3:45  
Room 114

*Lecture recordings available on Canvas*

**Instructor: Prof. David Klaus**  
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## Course Objectives

Utilize systems engineering methods to design and analyze a spacecraft intended for human occupancy and provide a functional knowledge of the technologies used to sustain life. Emphasis is placed on deriving requirements from stated mission goals and objectives, developing integrated functional schematics into a conceptual design, and comparing design options by parametric trade study and mass estimation.

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## Office Hours

'to be announced' after polling the class

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Textbook - outline references chapters in 1<sup>st</sup> ed., additional materials will be provided as we go along

*Human Spaceflight Mission Analysis and Design*, Larson and Pranke (1<sup>st</sup> edition, hardcopy)

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

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

Introduction to Human Spaceflight – Ch 1  
Human Space Mission Objectives – Ch 2  
Space Environments – Orbit, Planets and NEO's – Ch 3, 4  
Human Physiology – Ch 5  
Ergonomics, Human Factors and Psychology – Ch 6, 7

**Exam 1 ~ Requirement Drivers / Oct 3**

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

Orbit Selection – Ch 9  
Entry / Descent/ Landing / Ascent – Ch 10

Functional Decomposition

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

Defining and Sizing Spacecraft Elements – Ch 11, 12, 13  
Human-Rating Process – *Accommodate, Utilize and Protect*  
'Human in the Loop' Design Drivers  
Determining Habitable Volume

Environmental Control & Life Support System (ECLSS) Functions & Enabling Technologies – Ch 17  
Atmosphere Management  
Water Management  
Food Supply  
Waste Processing

Crew and Payload Accommodations (CA / PA) – Ch 18  
Spacesuits and Extravehicular Activity (EVA) – Ch 22

**Exam 2 ~ Design Process / Nov 12**

Functions, Integration and Interfaces summarized for the following remaining spacecraft subsystems  
Structures – Ch 21  
Command, Control and Communication (C3) – Ch 27  
ADCS / GNC – Ch 19  
Power – Ch 20  
Thermal Control – Ch 16  
*in situ* Resource Utilization (ISRU) – Ch 15  
Spacecraft Propulsion – Ch 24  
Launch / Transfer Systems – Ch 25

Risk Management – Ch 8  
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  
Requirement Compliance Verification and Design Validation  
CAD, Mockups, Prototypes, Test Articles, Flight Certification  
Launch & Mission Operations

**Final ~ Group Project Reports due and Final Presentations given on Mon Dec 16 from 4:30-7:00 pm**

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Grading

20% for Homework, Quizzes & Participation, 40% from 2 Exams (20% each), 40% from Group Project (with individual weighting as warranted). **Late submittals** will be penalized a minimum of 10% with up to 2% per day lost for each additional day late. This includes individual contributions to group submittals.

**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 (early vacation departure prior to fall and winter break not allowed).

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## **Policies on Disabilities, Absences, Behavior and other Guidelines**

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### **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 or injury, see [Temporary Medical Conditions](#) under the Students tab on the Disability Services website.

### **Classroom Behavior**

Students and faculty each have responsibility for maintaining an appropriate learning environment. 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. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. For more information, see the policies on [classroom behavior](#) and the [Student Code of Conduct](#).

### **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 policy may include: 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 the Honor Code ([honor@colorado.edu](mailto:honor@colorado.edu)); 303-492-5550). Students who are found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found at the [Honor Code Office website](#).

### **Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation**

The University of Colorado Boulder (CU Boulder) is committed to fostering a positive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct, intimate partner abuse (including dating or domestic violence), stalking, or protected-class discrimination or harassment by members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or [cureport@colorado.edu](mailto:cureport@colorado.edu). Information about the OIEC, university policies, [anonymous reporting](#), and the campus resources can be found on the [OIEC website](#). Please know that faculty and instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

### **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 let me know at least 2 weeks in advance of any conflicts and we will make arrangements on a case-by-case basis.

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