rev 8-25-2020

ASEN 5158
SPACE HABITAT DESIGN

Fall 2020
Tuesday/Thursday 2:50-4:05
Room 114 (hybrid)

Lecture recordings available on Canvas and real time remote participation via Zoom

Instructor: Prof. David Klaus
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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

Mondays TBD (remote by Zoom this semester)

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://store.spacetechnologyseries.com/ebooks/5-human-spaceflight-mission-analysis-and-design-2nd-ed.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

Exam 1 ~ *Requirement Drivers*

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
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
- Determining Habitable Volume

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 (EVA)

Exam 2 ~ *Design Process*

Functions, Integration and Interfaces summarized for the following remaining spacecraft subsystems
- Structures
- Command, Control and Communication (C3)
- ADCS / GNC
- Power
- Thermal Control
- *in situ* Resource Utilization (ISRU)
- Spacecraft Propulsion
- Launch / Transfer Systems

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

Final ~ *Group Project Reports due and Final Presentations given on Thursday, Dec. 10, 4:30–7 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 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).

Policies on Disabilities, Absences, Behavior and other Guidelines

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 policies on classroom behavior and the Student Code of Conduct.

Requirements for COVID-19

As a matter of public health and safety due to the pandemic, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements, and public health orders in place to reduce the risk of spreading infectious disease. Required safety measures at CU Boulder relevant to the classroom setting include:

- maintain 6-foot distancing when possible,
- wear a face covering in public indoor spaces and outdoors while on campus consistent with state and county health orders,
- clean local work area,
- practice hand hygiene,
- follow public health orders, and
- if sick and you live off campus, do not come onto campus (unless instructed by a CU Healthcare professional), or if you live on-campus, please alert CU Boulder Medical Services.

Students who fail to adhere to these 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 policies on COVID-19 Health and Safety and classroom behavior and the Student Code of Conduct. If you require accommodation because a disability prevents you from fulfilling these safety measures, please see the "Accommodation for Disabilities" statement on this syllabus. Before returning to campus, all students must complete the COVID-19 Student Health and Expectations Course. Before coming on to campus each day, all students are required to complete a Daily Health Form.

Students who have tested positive for COVID-19, have symptoms of COVID-19, or have had close contact with someone who has tested positive for or had symptoms of COVID-19 must stay home and complete the Health Questionnaire and Illness Reporting Form remotely. In this class, if you are sick or quarantined, please notify me and we will develop an appropriate plan of action.

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 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 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); 303-492-5550). Students 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 an inclusive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (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. 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, dating and domestic violence, stalking, 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 notify me and we will develop an appropriate plan of action.

See the campus policy regarding religious observances for full details.

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.