ASEN 6116

Spacecraft Life Support Systems

Credits (3)
TuTh, 1:15pm-2:30pm, AERO N240
Prof. James Nabity, AERO N305, 303-492-3243, james.nabity@colorado.edu
Office hrs: 11am - noon, Tu or by appointment

Course Description:

In this course we study the spacecraft environmental control and life support systems (ECLSS) and technologies that keep people alive and healthy. What are the physiological needs of astronauts and what are the available technologies to meet them? How do the mission requirements affect the ECLSS design? Students will study thermal control systems, air revitalization processes, water reclamation and treatment, waste handling and the reuse of materials, along with food and nutrition. Teams will develop analytical models from first principles followed by computational studies to explore novel technological approaches to environmental control and life support. Upon completing this course students should be able to:

1) describe the technical challenges of life support that we face when leaving Earth for the frontier of space,
2) define the functional requirements for a spacecraft life support system,
3) comprehend and describe the physicochemical processes used in ECLSS and comparatively assess competing technologies,
4) design, analyze and test advanced ECLS components and systems, and
5) apply this knowledge to discover and develop better ways to support the human exploration of space.

The semester concurrently entails a series of lectures, assignments and analytical/computational investigations. Student work is evaluated by performance on homework assignments and quizzes, an individual research paper, an individual comprehensive exam, a team paper describing analytical and computational results (journal article quality) and a team presentation to the class.

Prerequisite / Co-requisite:

ASEN 5158 Space Habitat Design, ASEN 5016 Space Life Sciences, or approval of the instructor

Required Materials:

Anderson, Molly S. et al. (2018), Baseline Values and Assumptions Document, NASA/TP-2015–218570. Available online at https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiJzL6xo5TuAhUWOs0KHcmRBUoQFjACegQIBhAC&url=https%3A%2F%2Fntrs.nasa.gov%2Fapi%2Fcitations%2F20180001338%2Fdownloads%2F20180001338.pdf%3Fattachment%3Dtrue&usg=AOvVaw0Ta-ud4RMQNwZ7qbT5syNn.

P.O. Wieland (1998), “Living together in space the design and operation of the life support systems on the International Space Station,” NASA/TM—98–206956/VOL1. Available online at

http://spaceflightsystems.grc.nasa.gov/repository/NRA/tm206956v1%20living%20together%20%20in%20space.pdf

Exposure Guidelines (SMACs & SWEGs)

https://www.nasa.gov/feature/exposure-guidelines-smacs-swegs

SMACs - Spacecraft Maximum Allowable Concentrations for Selected Airborne Contaminants
SWEGs - Spacecraft Water Exposure Guidelines for Selected Waterborne Contaminants

Recommended (but not required) Supplemental Materials:

Erik Seedhouse, Life Support Systems for Humans in Space, Springer Praxis Books, ISBN 978-3-030-52859-1, 2020. https://www.springer.com/gp/book/9783030528584

Courtney G Brooks, James M. Grimwood, Loyd S. Swenson, Chariots for Apollo: A History of Manned Lunar Spacecraft, NASA Special Publication 4205, https://history.nasa.gov/SP-4205.pdf

Peter Eckart, Spaceflight Life Support and Biospheres, Space Technology Library, Microcosm Press and Kluwer Academic Publishers, 1996. $199.99 for paperback from Springer, Amazon Market Place and other sources.

Wiley J. Larson and Linda K. Pranke, Human Spaceflight Mission Analysis and Design, Space Technology Series, The McGraw-Hill Companies, 2007.

Carol Norberg, Human Spaceflight and Exploration, Springer Praxis Books, ISBN 978-3642237249, 2013. $149.99, https://www.springer.com/us/book/9783642237249

Course Assignments (additional information to be provided when assigned):

- Research Paper: A Life Support Technology Review – Individual Work, 20% of final grade
- Mid-term Take Home Exam – Individual Work, 25% of final grade
- Investigative Study: A journal quality research paper and presentation to report results – Team Work, 35% of final grade
- Quizzes – Individual Work, 10% of final grade
- Homework – Individual Work, 10% of final grade

Academic Integrity and Grade Schedule:

Letter Grade	Percent Grade	4.0 Scale
A	93-100	4.0
A-	90-92	3.7
B+	87-89	3.3
B	83-86	3.0
B-	80-82	2.7

Letter Grade	Percent Grade	4.0 Scale
C+	77-79	2.3
C	73-76	2.0
C-	70-72	1.7
D	65-69	1.0
F	Below 65	0.0

Successful students will put in approximately 12-15 hrs per week to complete the assignments and earn a B or better grade in this course. *Late work (i.e. that work turned in after the deadline given by the instructor) will be docked 10 pts or one full letter grade for each week late.* For AES graduate students, a course mark below B- is unsatisfactory and will not be counted toward fulfilling the minimum requirements for the degree.

Student attendance is an important part of your training as an engineer and scientist. A cordial atmosphere is expected at all times within the classroom and laboratory. Respect and be courteous to other students. Maintain a quiet work atmosphere; excessive noise distracts others. Assist your fellow graduate students. This is an important part of your training for the future. You will often be working in a group environment, so be a responsible team member. When you are required to share equipment with others, transfer data/codes/etc., do so in a professional manner. We expect that students follow the highest standards of ethics in their research and publications. Plagiarism, data manipulations, etc. are examples of unethical behavior and are not tolerated. The instructor or your advisor can help you and/or refer you to the proper channels if the ethical line is not clear.

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.

All students who are new to campus must complete the COVID-19 Student Health and Expectations Course. Before coming to campus each day, all students are required to complete the Buff Pass.

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. In this class, if you are sick or quarantined, please notify me via email. Be advised that because of FERPA student privacy laws, you are not required to state the nature of your illness.

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.

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, the due dates for completion of assignments and the take home exam will be scheduled to avoid conflict with the observance of religious holidays. Please notify your professor should a conflict or need arise due to religious observance obligations.

See the campus policy regarding religious observances for full details.

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 graduate 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.

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.