ASTE 529 SAFETY OF SPACE SYSTEMS AND SPACE MISSIONS

Units: 3.0

Term—Day—Time:

Spring 2023 Tuesday 6:40-9:20pm

Engineering methodology and analysis techniques for safety certification and mission assurance of robotic and human space systems and space missions by government and commercial industry.

Open only to Engineering graduate students.

Location: USC Distance Education Network (DEN) only.

Instructor: Michael T. Kezirian, PhD

Office: virtual

Office Hours: By Appointment

Contact Info: Kezirian@usc.edu

Timeline for replying to emails/calls (i.e. generally within 24 hours).

Course Description

In spaceflight, a human-rating certification is the assurance that the space system accommodates human needs, effectively utilizes human capabilities, controls hazards with sufficient certainty to be considered safe for human operations, and provides, to the maximum extent practical, the capability to safely recover the crew from hazardous situations. In the United States, the National Aeronautics and Space Administration (NASA) has developed the certification process and set technical requirements to be levied on crewed space systems in addition to the standards and requirements that are mandatory for visiting vehicles that are to dock with the International Space Station.

Learning Objectives

This course will teach the concepts of system safety: the methodology and analysis used to certify spacecraft vehicles and missions. Through this course technical engineers and program managers with a sound engineering foundation will gain the approach through system engineering to understand, design and certify missions for space applications. The concepts are geared toward human space flight and build on the last fifty years' experience of designing and operating crewed vehicles, but the same concepts and approaches also apply to unmanned scientific and communication satellite programs.

In 2020, the FAA developed and released streamlined requirements for certification of spacecraft; this course all considers this new approach, referred to as Part 450.

Prerequisite(s): None

Co-Requisite(s): None

Concurrent Enrollment: None

Recommended Preparation: ASTE 520 or some experience in space engineering.

Course Notes
Grading type is Letter Grade.

Technological Proficiency and Hardware/Software Required
USC Distance Education Network (DEN) tools and resources.

Required Readings and Supplementary Materials
- Safety Design for Space Systems by Gary Eugene Musgrave, Axel (Skip) M. Larsen and Tommaso Sgobba (ed) Butterworth-Heinemann, 2009
  https://doi.org/10.1016/B978-0-7506-8580-1.X0001-2

  NOTE: The Second Edition of this book is planned for Spring 2023.
  https://www.elsevier.com/books/safety-design-for-space-systems/sgobba/978-0-323-95654-3
  Hardcover ISBN: 9780323956543

- IAASS-SSI-1700 Commercial Human-Rated System, SAE Aerospace Standard, Issued 2018-07
  https://www.sae.org/publications/technical-papers/content/wp-0011/

- Instructor's Course Notes

Description and Assessment of Assignments
Weekly homework assignments consisting of short answer responses and completing safety assessments to proposed scenarios

Grading Breakdown

Assessment Tool (assignments)	Points	% of Grade
Homework, weekly assignments	140	26
Midterm Examination	200	37
Final Examination	200	37
TOTAL	540	100

Grading Scale
Grading is on a curve. Generally the course median approximates a high 'B' grade.

Assignment Submission Policy
Assignments will be submitted through the course portal. Due dates are enforced. Exceptions for unique obligations will be considered when requested in advance.

Grading Timeline
Graded homeworks will be returned one week after the submission deadline, except before the exams, when they will be returned earlier, if possible.

Additional Policies
In person attendance for course lectures is strongly encouraged. There are typically one or two guest lectures. In person attendance for these lectures are particularly appreciated. In the pa st, students have expressed the added value of attending in person as they are able to ask questions and receive answers real time.

Course Schedule: A Weekly Breakdown

There will be a homework assignment for each course lecture, due one week after the lecture. The due date for the last assignments before the midterm and final will be shorter.

	Topics/Weekly Lecture	**Readings/Preparation Chapters in Course Textbook**
Week 1 10-Jan-23	Course Introduction, NASA Definitions, Safety Process, Safety Products	1 & 4
Week 2 17-Jan-23	Safety Analyses, Human Ratings, NASA & FAA Requirements, Failure Tolerance, Design for Minimum Risk	5 & 19
Week 3 **24-Jan-23**	Crew Survivabilty/Safe Haven Launch Vehicle FTS and Crew Escape Systems	
Week 4 **31-Jan-23**	Bioastronautics Life Support Systems	-- 6
Week 5 7-Feb-23	Propulsion Systems Safety	20
Week 6 14-Feb-23	Avionics Safety Software System Safety	14 15
Week 7 21-Feb-21	Nuclear Systems Safety	Notes
Week 8 28-Feb-23	Electrical and Power Systems & Battery Safety Oxygen Systems, Toxic Environment & Fire	16 13, 18,.& 27
Week 9 7-Mar-23	**Midterm, no lecture or dedicated homework assignment**	
14-Mar-23	**2023 Spring Recess** No Lecture/No Homework	
Week 10 21-Mar-23	Structures and Mechanisms Systems Safety Non-Destructive Evaluation Pyrotechnic Devices Safety	17 Notes 21
Week 11 28-Mar-23	Crew Systems (Flight Suits, Seats) Extravehicular Activity & Docking Systems	22, 8 7
Week 12 4-Apr-21	The Space Environment: MicroMeteoroid and Orbit Debris (MMOD), Space Traffic Management	2, 10 & Notes
Week 13 11-Apr-23	Space Radiation Effects Ground Processing Environment	2.5 and 26
Week 14 18-Apr-23	Flight Operator & Crew Training as Safety Controls	25
Week 15 25-Apr-23	Probability Risk Assessment Crew Survivability Report	29 & Notes HW due April 28, 2023
FINAL		**May 10, 2023** **7-9 pm**

Statement on Academic Conduct and Support Systems

Academic Conduct:

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, "Behavior Violating University Standards" policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, policy.usc.edu/scientific-misconduct.

Support Systems:

Counseling and Mental Health - (213) 740-9355 – 24/7 on call
studenthealth.usc.edu/counseling
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call
suicidepreventionlifeline.org
Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention and Services (RSVP) - (213) 740-9355(WELL), press "0" after hours – 24/7 on call
studenthealth.usc.edu/sexual-assault
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED)- (213) 740-5086 | Title IX – (213) 821-8298
equity.usc.edu, titleix.usc.edu
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university prohibits discrimination or harassment based on the following *protected characteristics*: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations. The university also prohibits sexual assault, non-consensual sexual contact, sexual misconduct, intimate partner violence, stalking, malicious dissuasion, retaliation, and violation of interim measures.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298
usc-advocate.symplicity.com/care_report
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity |Title IX for appropriate investigation, supportive measures, and response.

The Office of Disability Services and Programs - (213) 740-0776
dsp.usc.edu
Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Support and Advocacy - (213) 821-4710
uscsa.usc.edu
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101
diversity.usc.edu
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call
dps.usc.edu, emergency.usc.edu
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call
dps.usc.edu
Non-emergency assistance or information.