ASTE 599
SAFETY OF SPACE OPERATIONS
TUESDAYS 6:40 – 9:20 PM
SPRING 2025 SYLLABUS

Course Instructor:	Michael T. Kezirian, PhD	
Affiliation:	Adjunct Professor of Astronautics Practice, University of Southern California	
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Course Instructor:	Jerry Haber	
Author Affiliation:	Lecturer, University of Southern California & Distinguished Scientist, ARCTOS (retired)	
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COURSE DESCRIPTION:

The astronautical engineering course focuses the risks of spacecraft and launch vehicle operations, the regulatory requirements for managing these risks, and the technology to implement the risk management regime. The course begins with the fundamentals of the operation of space activities. The first part of the course explores on-orbit risk management. The course will consider environmental hazards, specifically the threats posed by micrometeoroid and orbital debris. It will also explore key issues of space traffic management and space situational awareness, critical to the operation of spacecraft and constellations of spacecraft working collectively.

The second part of the course addresses launch and reentry risks. It begins with introducing the engineering basics associated with understanding, analyzing, and managing these risks. Important elements of this include understanding risk measures, risk drivers and the levels of fidelity of data development and analysis that may be required in order to ensure operations are "safe-enough". The course considers characterizing sources of risks (normal vehicle operations, vehicle malfunctions), resulting hazards (debris – inert and explosive), populations and assets at risk, propagation of hazards to populations at risk, quantifying risk and designing risk mitigation strategies, as needed.

COURSE FORMAT:

Spring 2025:	14 course Lectures Midterm and Final Exams
Class Session:	Tuesdays 6:40-9:20pm (Pacific)
Dates:	January 13 – May 2 (No scheduled lecture on March 4, midterm examination) (Class does not meet on March 18, Spring Recess) Midterm: Tuesday, March 4; Final: Determined by USC Schedule
Location:	Course available through USC Distance Education Network (DEN) only.

COURSE GRADING:

Homework (Due Weekly):	30%
Mid-term Exam:	35%
Final Exam:	35%
	Total: 100%

REQUIRED TEXT AND MATERIALS:

- *Firooz A. Allahdadi, Isabelle Rongier and Paul D. Wilde, Safety Design for Space Operations, 2013, Butterworth-Heinemann, ISBN 978-0-08-096921-3*

- Federal Aviation Administration (FAA) Advisory Circulars:
  - *AC 450.115-1B High Fidelity Flight Safety Analysis*
  - *AC 450.117-1 Trajectory Analysis for Normal Flight*
  - *AC 450.108-1 Flight Abort Rule Development*
  - *AC 450.123 Population Exposure Analysis*
  - *AC 450.161-1 Control of Hazard Areas*

- Instructors' Course Notes

Instructor – Prof. Michael Kezirian

Dr. Kezirian is a specialist in space safety. A former Associate Technical Fellow for the Boeing Company, he most recently supporting the Commercial Crew Program (Boeing CST-100 Starliner). He was active in the operations of government and commercial satellite programs and NASA human spaceflight programs. For the Space Shuttle Program (Orbiter) he was certified for the launch console in the Mission Engineering Room and represented safety at the Mission Management Team. He is also an expert in Composite Overwrapped Pressure Vessels, having served as the analysis lead for the Space Shuttle Program. This team addressed the design and operational risks for the stochastic failure mode of composite stress rupture. He chairs the AIAA aerospace pressure vessel standards committee and is a member of the AIAA Standards Steering Committee.
Prior to his work on the Space Shuttle, International Space Station and Boeing Commercial Crew Programs, Dr. Kezirian was a spacecraft autonomy engineer for government communication and commercial satellite programs at Boeing and a propulsion engineer at TRW Space and Technology (now Northrop Grumman) in Southern California. He is the editor-in-chief of the *Journal of Space Safety Engineering*, co-editor of the 2nd edition of the book, Safety Design for Space Systems and President of the International Space Safety Foundation.

Instructor - Jerry Haber

Jerry Haber is a retired Distinguished Scientist formerly with ARCTOS, an expert in modeling and regulatory support for launch and reentry safety. He currently provides Flight Safety consulting and training through the consulting firm of JHaber, Consulting. In 2019, he was awarded the Jerome Lederer Space Safety Pioneer award by the International Association for the Advancement of Space Safety (IAASS) for his leadership in launch and reentry safety modeling, safety criteria development and analyses since 1968. He was the technical lead on modeling and policy formulation for the guidelines employed by the US National Ranges (RCC 321). He has supported space-lift programs ranging from the early Scout launchers thru the Space Shuttle to modern launchers. He has taught courses in launch and reentry safety to the staffs of the major national ranges, international space agencies and launch operators for more than a decade.

SESSION-BY-SESSION OUTLINE (SCHEDULE TO CHANGE BEFORE FIRST LECTURE):

Week	Date	Topic	Notes	Homework
1	14-Jan-25	Course Introduction Orbital Debris Environment	1	Due
2	21-Jan-25	Space Debris Fundamentals	2	1
3	28-Jan-25	Assessing Collision Risk Evaluating Separation Distance & Probability of Collision	3	2
4	4-Feb-25	Collision Avoidance Maneuver Planning Maneuver Go / No-Go Criteria	4	3
5	11-Feb-25	Launch Collision Assessment	5	4
6	18-Feb-25	Designing Satellite Constellations	6	5
7	25-Feb-25	No Scheduled Lecture; Midterm Examination (7:00 – 9:00 PM)	7	6
8	4-Mar-25	**Launch and Reentry** Objectives of Flight Safety Analysis Stakeholders Measures Processes Analysis Levels of Fidelity	7	
9	11-Mar-25	Risk Acceptability Overview of the Analysis Procedure Assessing the Level of Fidelity Required	8	7
	18-Mar-25	No Class: Spring Recess March 13-20		
10	25-Mar-25	Public Safety Criteria Malfunctions Failure Probability Breakup Lists Flight Termination Criteria	9	8
11	1-Apr-25	Where did the debris go? Debris Footprint Concept Corridor Approximation	10	9
12	8-Apr-25	Human Vulnerability- Inert Debris Human Vulnerability- Explosive Debris Transportation (Vulnerability)	11	10
13	15-Apr-25	Planned and Random Reentry Risk	12	11
14	22-Apr-25	Hypothetical Analysis: Tabakawea	13	12.
15	29-Apr-25	Integration with National Air Space: Regulations and Standards for US Launch and Reentry Operations Spaceport Selection	14	13
	6-May-25 TBD	May 3-6 Study Days (HW 14 Due May 2) Final Examination (7:00 – 9:00 PM)		14

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 Section 11, Behavior Violating University Standards https://scampus.usc.edu/1100-behavior-violating-university-standards-and-appropriate-sanctions. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct.

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the Office of Equity and Diversity http://equity.usc.edu or to the Department of Public Safety http://adminopsnet.usc.edu/department/department-public-safety. This is important for the safety of the whole USC community. Another member of the university community – such as a friend, classmate, advisor, or faculty member – can help initiate the report, or can initiate the report on behalf of another person. The Center for Women and Men http://www.usc.edu/student-affairs/cwm/ provides 24/7 confidential support, and the sexual assault resource center webpage http://sarc.usc.edu describes reporting options and other resources.

SUPPORT SYSTEMS

A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the American Language Institute http://dornsife.usc.edu/ali, which sponsors courses and workshops specifically for international graduate students. The Office of Disability Services and Programs http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, USC Emergency Information http://emergency.usc.edu will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.