ASTE 599
SAFETY OF SPACE OPERATIONS
TUESDAYS 6:40 – 9:20 PM
SPRING 2022 SYLLABUS (SECTION 28492)

Course Instructor:	Michael T. Kezirian, PhD
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COURSE DESCRIPTION:

The astronautical engineering course focuses the risks of orbital and suborbital operations, the regulatory requirements for managing these risks, and the technology to implement the risk management regime.

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. In addition, the course will cover the operational issues association with extravehicular activity.

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 2019:	14 course Lectures Midterm and Final Exams
Class Session:	Tuesdays 6:40-9:20pm (Pacific)
Dates:	January 10 – April 29 (No scheduled lecture on March 5, midterm examination) (Class does not meet on) Midterm: Tuesday, March 5; 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*

- *FAA Draft Advisory Circular AC 450.115-1 High Fidelity Flight Safety Analysis*

- 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 led the COPV Analysis Team for the Orbiter Project (Space Shuttle) and was a key COPV design engineer for the Nitrogen Oxygen Recharge System for the International Space Station and the COPV Composite Stress Rupture for the Orbiter (Space Shuttle). Previously, 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* and President of the International Space Safety Foundation.

Instructor - Jerry Haber

Jerry Haber is a Scientist at ARCTOS, an expert in managing launch and reentry safety. In 2019, he was recently 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):

Class	Date	Topic	Notes	Homework
1	11-Jan-22	Course Introduction; Orbital Debris Environment	1	Due
2	18-Jan-22	Space Surveillance, orbit determination and object orbit propagation of space debris	2	1
3	25-Jan-22	Government and Industry Tools for Mission Planning	3	2
4	1-Feb-22	Assessing Collision Risk (on Orbit) Collision Avoidance Go / No-Go Criteria Collision Avoidance Maneuvers	4	3
5	8-Feb-22	Launch Collision Avoidance	5	4
6	15-Feb-22	Space Traffic Management / Space Situational Awareness Large Constellations	6	5
7	22-Feb-22	Operations and Design of Spaceports Extravehicular Activity Operations	7 Ch 2c TBD	6
8	1-Mar-22	No Scheduled Lecture; Midterm Examination (7:00 – 9:00 PM)	8	
	8-Mar-22	**Launch and Reentry** Objectives of Flight Safety Analysis Stakeholders Measures Processes Analysis Levels of Fidelity		7
	15-Mar-22	No Class: Spring Recess March 13-20		
9	22-Mar-22	Risk Acceptability What is the Problem to be Solved? General Risk Analysis Procedures	9	8
10	29-Mar-22	Supporting Data Requirements Impact Prediction and Debris Footprint Impact probabilities of Scheduled Debris	10	9
11	5-Apr-19	Impact Dispersions of Normal and Malfunctioning Vehicles	11	10
12	12-Apr-19	Corridor Approach to Risk Analysis	12	11
13	19-Apr-19	Planned and Random Reentry Risk	13	12
14	26-Apr-19	Range Safety Risk Management and Risk Mitigations	14	13
	30-Apr-19 *TBD*	April 30 – May 3 Study Days (HW Due April 29) 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.