USC Viterbi
School of Engineering

Department of Astronautical Engineering
Mike Gruntman, Ph.D.
Professor of Astronautics

October 14, 2022

To: **Astronautics Students**
Students Enrolled in Astronautics Classes
Astronautics Program Instructors
Astronautics Program Supporters and Friends

Astronautics Master's Program Update

As always this time of the year, we provide an update on the recent developments in the program ***Master of Science in Astronautical Engineering*** or **MS ASTE**.

1) The Master of Science program in astronautical engineering (MS ASTE) is in excellent shape (see statistics pp. 3, 4). From humble beginnings and in a record short time since its founding in 2004, it has grown into a major, among largest, internationally recognized space-engineering program. We reach students all over the United States and Canada as well as at military installations at home and abroad.

The Department awarded more than 810 Master of Science ASTE degrees from 2004-2022. During the last 5 years, it was on average 57 Master's degrees annually.

2) The required course ASTE-470 in spacecraft propulsion has been replaced by the *identical in content course* **ASTE-575** (pp. 9, 20, 21). This class will be offered in the spring semesters.

> ASTE-470 was offered for the last time in Fall 2022 for undergraduate students only. Some Master's students were also taking this course as needed for graduation or other academic reasons.

3) The offering of **ASTE-584** *Spacecraft Power Systems* in the spring of 2023 is on track (pp. 9, 12, 13, 15) after a 7-year interruption. See ASTE-584 description on page 12.

Another Astronautics course, **ASTE-501a** *Physical Gas Dynamics*, may also resume in the fall of 2023.

4) In the Spring 2023, **ASTE-523** Design of Low Cost Space Missions will focus on an unusual topic, building a lunar colony. See ASTE-523 project description on page 11

5) The newsletter provides program news, a long-term course schedule, and other information about coursework of interest to our current, past, and future students. Please always check with ASTE Student Services Director about the near-term course schedule.

University of Southern California
3650 McClintock Ave., OHE-530G, Los Angeles, CA 90089-1451 · Tel: 213 740 5536 · mikeg@usc.edu

6) Meet ASTE staff (photos on the right).

Please do not hesitate to contact Astronautics Business Manager Ms. **Dell Cuason** (OHE-500U; tel. 213-821-5817; cuason@usc.edu) should you have any questions about the program.

Ms. **Marlyn Lat** (OHE-500V; tel. 213-740-4009; marlynlat@usc.edu). supports various administrative, student admission, and budgetary operations of the department.

Ms. **Linda Ly** (OHE-530B; tel. 213-740-7228; lylinda@usc.edu) supports the business operations of the department and research grants and contracts of the faculty.

Mr. **Luis Saballos** (OHE-500Q; tel. 213-821-4234; lsaballo@usc.edu) is ASTE's Student Services Director.

Ms. **Prisila Vasquez** (OHE-500U; tel. 213-764-7919; prisilac@usc.edu) is ASTE's Student Services Assistant Director.

Luis and Prisila are the first contacts for students on questions regarding class registration, schedule, and admission to programs in astronautics. Before your inquiries, check MS ASTE's frequently asked questions at http://astronauticsnow.com/msaste/faq.html.

ASTE staff: Dell Cuason (top), Linda Ly, Marlyn Lat, Luis Saballos, Prisila Vasquez (bottom)

7) Please find below

(a) ASTE program statistics (pp. 3-4)
(b) recent books by Astronautics instructors (pp. 5-6)
(c) student resources – *The Space Show* (p. 7)
(d) USC Astronautics at the 73rd IAC (p. 8)
(d) Astronautics program classes in the Spring, Summ~~er and Fall semesters~~ of 2023 (pp. 9-19)
(e) long-term class schedule (pp. 20, 21)
(f) MS ASTE catalog description (pp. 22-24)
(g) admission requirements, transfer to graduate degree programs in Astronautical Engineering, GPA, leave of absence, and graduation (pp. 25-28)

Ad Astra!

Mike Gruntman
Professor of Astronautics
Director, *MS in Astronautical Engineering*

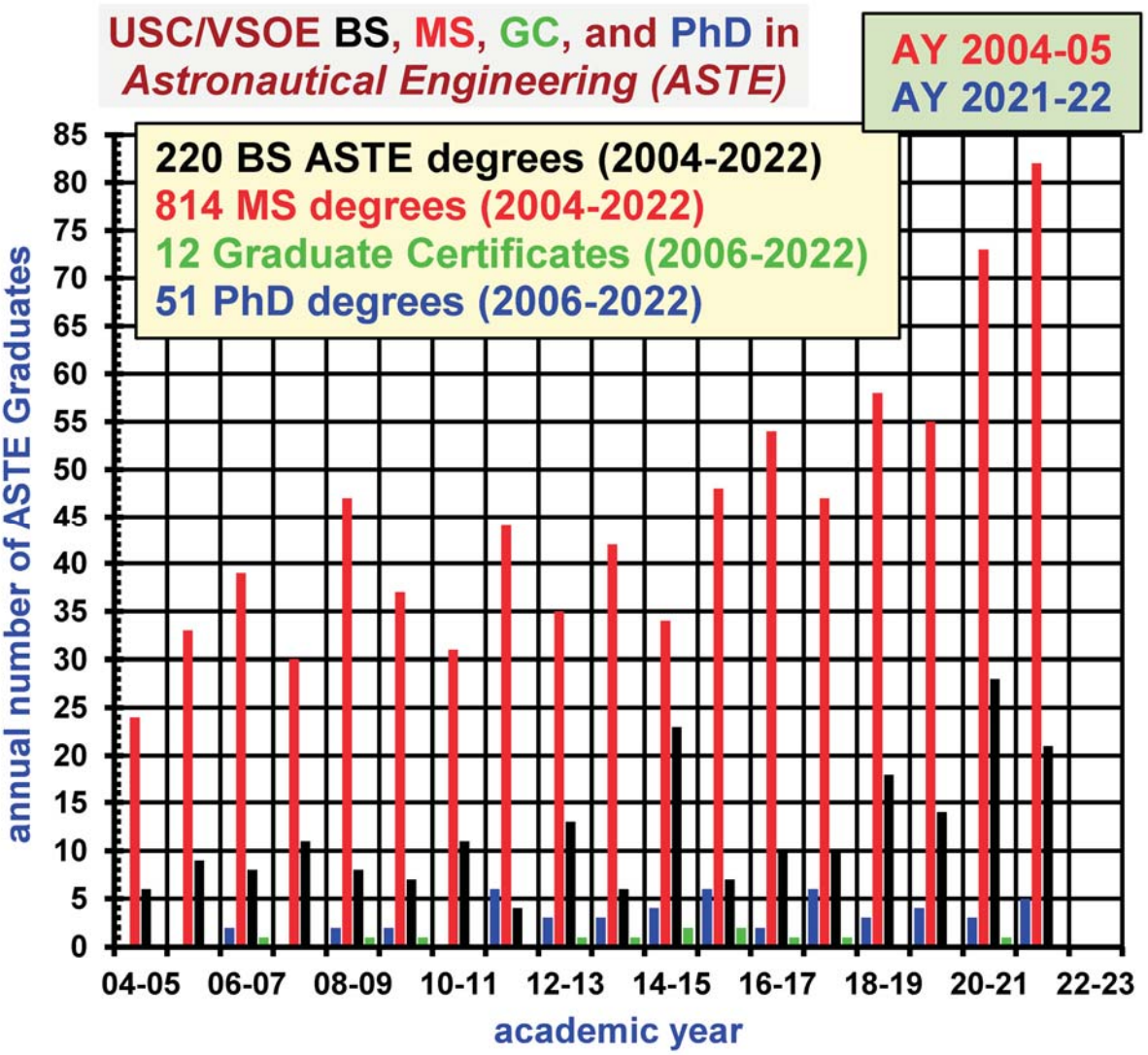
P.S. We have to amend our motto on reaching the stars as government and university regulations are becoming more and more bureaucratic, burdensome, and restrictive rather than inspirational.

Per aspera (et statuta) ad astra!

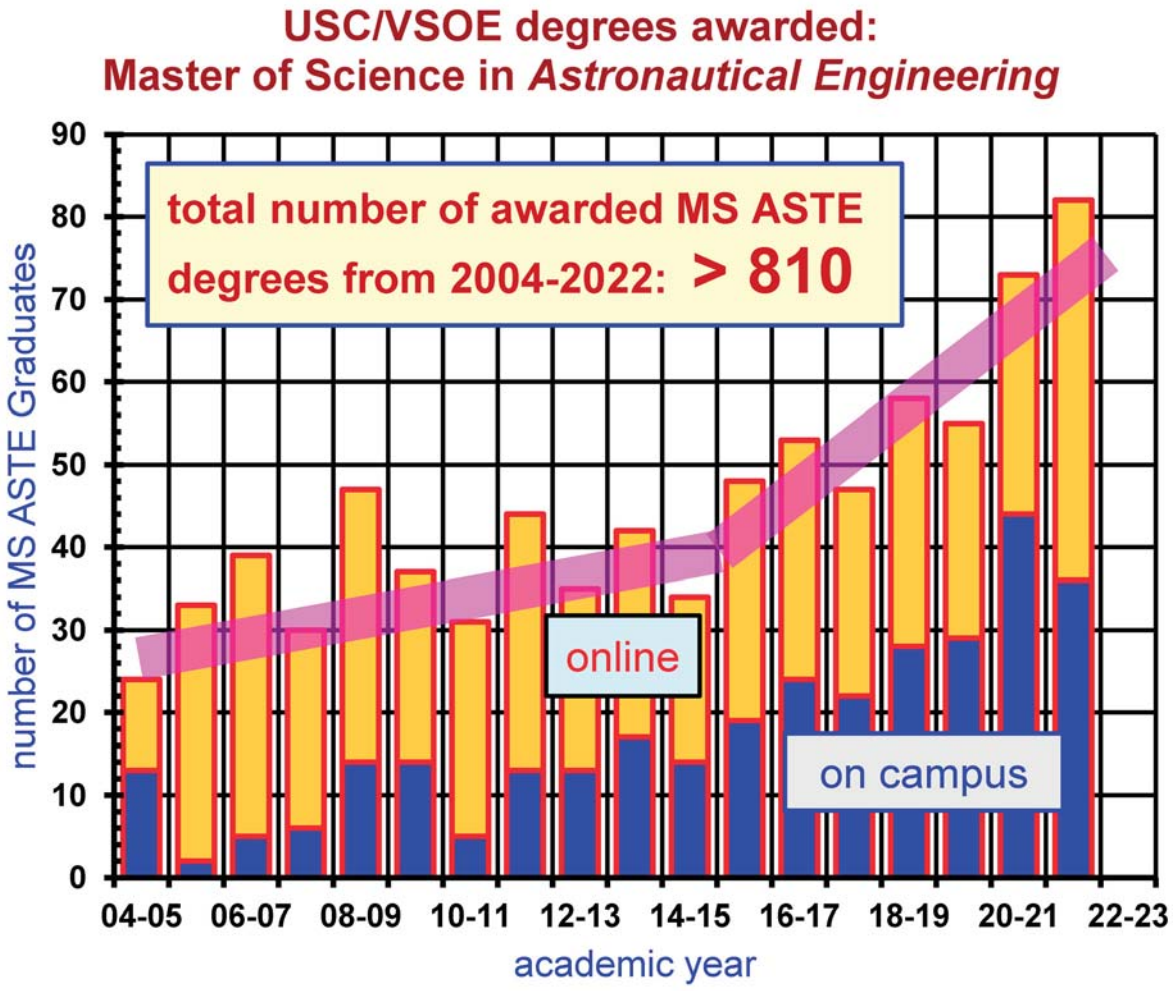
Degrees in Astronautical Engineering – Statistics

Through difficulties (and [unfortunately burdensome] regulations) to the stars!

Since its founding in 2004, the Astronautical Engineering Department offers the full set of degrees in *Astronautical Engineering* (ASTE) – see figure below.



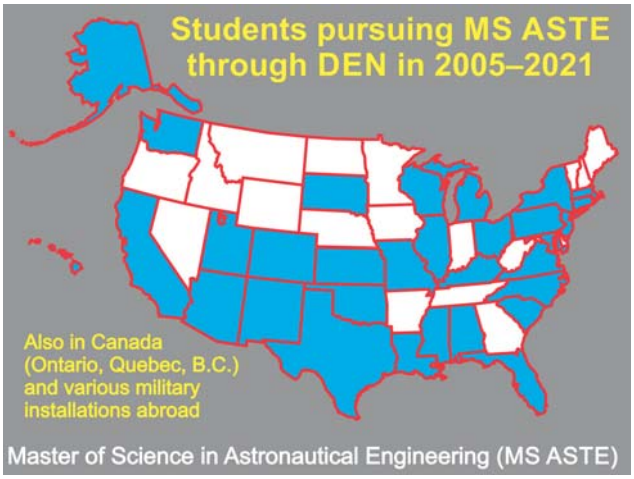
From AY 2004-2005 to AY 2019-2021, the Department has awarded **220** Bachelor of Science degrees, **814** Master of Science degrees, **51** PhD degrees, and **12** Graduate Certificates.



The Master of Science in Astronautical Engineering (MS ASTE) program awarded more than **800** degrees from 2004-2022.

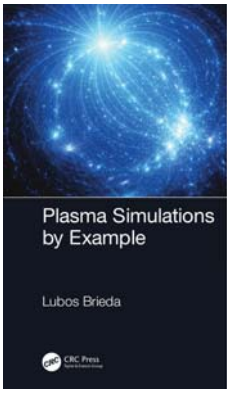
Full-time on-campus students earn now about one-half of the degrees. Online students account for the other half of the students.

The program reaches students all over the United States and Canada as well as at military installations at home and abroad through Viterbi's Distance Education Network (DEN).



MS ASTE flagship class, *Spacecraft Systems Design* (ASTE 520) More than **2300** graduate students enrolled in ASTE-520 since 1994.

Recent Books by Astronautics Instructors



Lubos Brieda

Plasma Simulations by Example

CRC Press, 2021

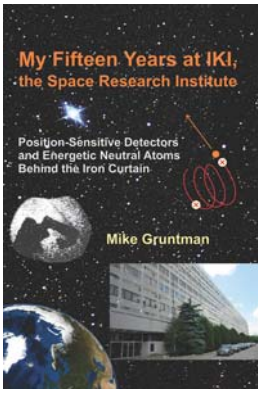
ISBN 978-1032176147 (paperback)

Don Edberg and Willie Costa

Design of Rockets and Space Launch Vehicles

AIAA, 2020

ISBN 978-1624105937

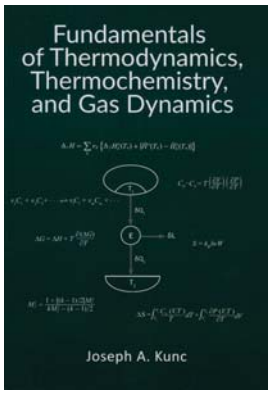


Mike Gruntman

My Fifteen Years at IKI, the Space Research Institute: Position-Sensitive Detectors and Energetic Neutral Atoms Behind the Iron Curtain

Interstellar Trail Press, 2022

ISBN 979-8985668704



Joseph A. Kunc

Fundamentals of Thermodynamics, Thermochemistry, and Gas Dynamics

2020

ISBN 978-1733009805

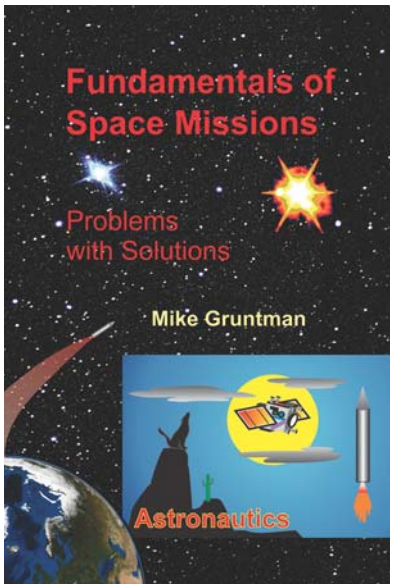
Recent Books by Astronautics Instructors

Fundamentals of Space Missions:

Problems with Solutions

Mike Gruntman

Interstellar Trail Press, 2022

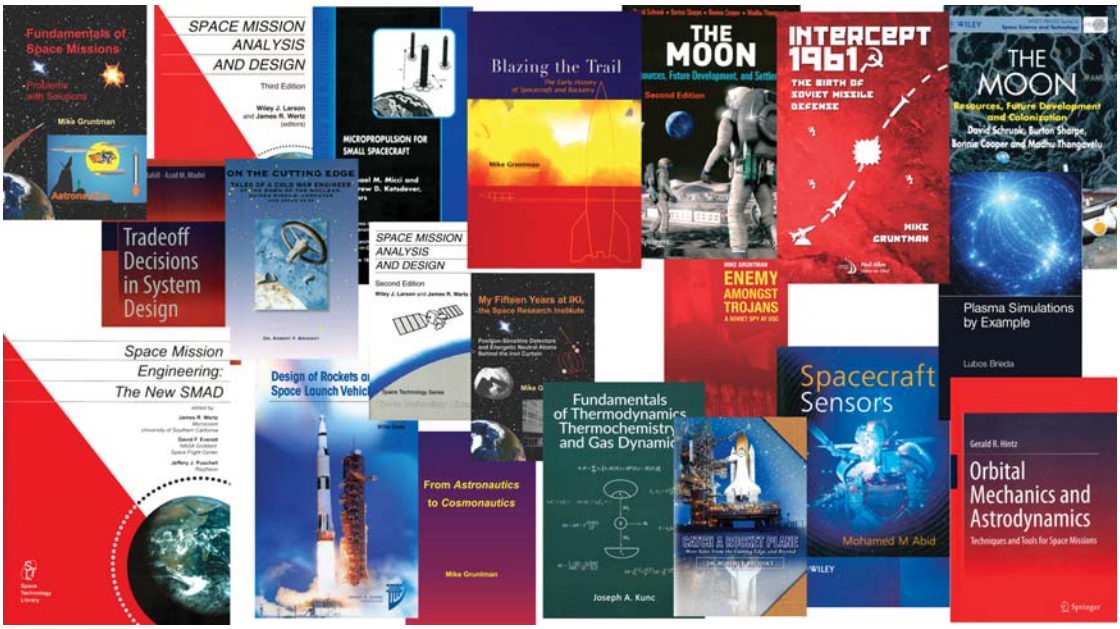


ISBN 979-8985668742 478 pages with 175+ figures

160+ typical homework and exam problems that *were* given, *could* have been given, or *should* have been given (had the time allowed) in ASTE-520 (AME-501 in ancient times).

List of problems at http://astronauticsnow.com/fsm2022/

Books by Astronautics faculty and instructors



The Space Show – Resource for Students

The Space Show has been on the air for more than 20 years and it is heard in more than 50 countries around the world.

http://thespaceshow.com

The host and USC Astronautics supporter, **Dr. David Livingston** (right), broadcasts a few times each week. In contrast to many radio talk shows, the discussions with guests last 1.5 hours or longer which allows for in-depth coverage of various topics.

This is one of the best informative and educational programs on the radio that brings problems and challenges of our vast space enterprise to a diverse audience of listeners across the globe. Space policies and politics; science, technologies, and education; entrepreneurial endeavors and innovations; "new" and "legacy" space – all are discussed by stellar guest specialists.

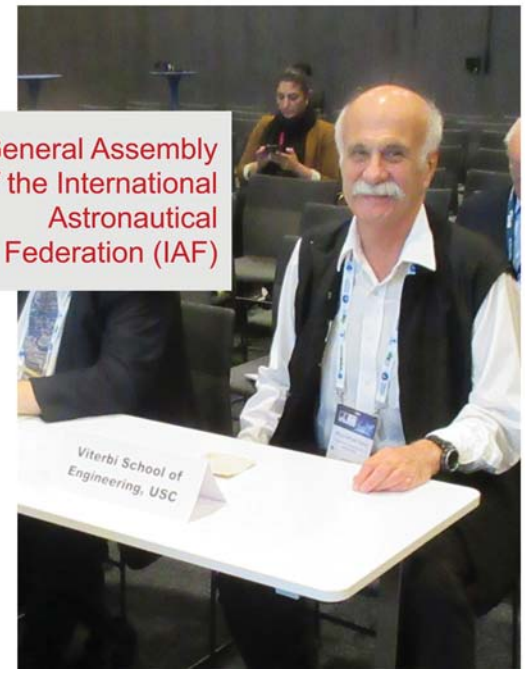
The Space Show focuses on timely and important issues influencing the development of outer-space commerce, space tourism, space exploration, and space development. The Space Show is committed to facilitating our becoming a space-faring nation and society with a growing and self-sustaining space-faring economy.

While the primary focus of the Space Show is on the “new” space ventures, it also covers traditional areas of the space enterprise. Many leading specialists including former NASA administrators, top scientists and technologists, space entrepreneurs, authors, and leaders of space advocacy groups were among its guests. **The list also includes at least six USC Astronautics (ASTE) instructors.**

All shows – **more than 3900** – are archived and conveniently accessible through the new flashy website **http://thespaceshow.com**. One can search for various topics and guests, download mp3 files (usually 30-50MB), and listen on computers or other devices. Many listen to programs live on the Internet and call in with questions.

The Space Show is a great resource for Astronautics students.

USC Astronautics at the 73rd International Astronautical Congress (IAC)



Schedule of Astronautics Courses

When you plan your coursework, please always check in advance with ASTE Student Adviser about the availability of the chosen courses.

While we carefully plan our course offerings, it is the Dean's Office that makes the final scheduling decision. Then, there is a challenge of the availability of DEN studios. You may call it, using the language of physics and mathematics, the "boundary conditions" or "constraints." Also, sometimes our instructors from industry and government centers cannot offer scheduled courses due to work-related or personal emergencies.

We try to minimize such occurrences, but they are outside our direct control. Please always check in advance with ASTE Student Adviser about the availability of the chosen courses.

Special arrangements for some courses in the spring, summer, and fall semesters of 2023 (subject to change)

Spring 2023

ASTE 523 Design of Low Cost Space Missions
New project on lunar colony -- see page 11
Instructors: Prof. Jim Wertz (Microcosm)

ASTE 575 Rocket and Spacecraft Propulsion
New required course replacing ASTE-470.
Instructors: Prof. Mike Gruntman (USC)

ASTE 584 Spacecraft Power Systems -- see page 12
The course offering is resumed with new instructors.
Instructors: Drs. Steve Lapen and David E. Lee (NGC)

Limited enrollment

ASTE 556 Ground Communications for Satellite Operations
Instructor: Prof. David Barnhart (USC) enrollment limited to 12 students: 6 on-campus; 6 DEN-webcast

Special arrangements for some courses in the spring, summer, and fall semesters of 2023 (subject to change)

Summer 2023

ASTE 580 Orbital Mechanics I
Instructor: Prof. Ryan Park (JPL)

Fall 2023 -- limited enrollments

ASTE 501a Physical Gas Dynamics
Instructor: to be announced resumption of the course is under preparation
To be confirmed in the early summer
Check the status with ASTE Student Adviser

ASTE 527 Space Architecting Studio
Instructor: Madhu Thangavelu (AAA Vis.) enrollment limited to 12 students
6 on-campus; 6 DEN-webcast

ASTE 556 Ground Communications for Satellite Operations
Instructor: Prof. David Barnhart (USC) enrollment limited to 12 students:
6 on-campus; 6 DEN-webcast

ASTE 561 Human Factors of Spacecraft Operations
Instructor: Prof. Garrett Reisman (USC) enrollment limited to 21 students:
11 on-campus; 10 DEN-webcast

ASTE 523 Design of Low Cost Space Missions

ASTE 523 class project in Spring 2023:

A Commercial, Near-Term Lunar Settlement

Imagine that the Superbowl halftime show about 5 years from now is ready to begin

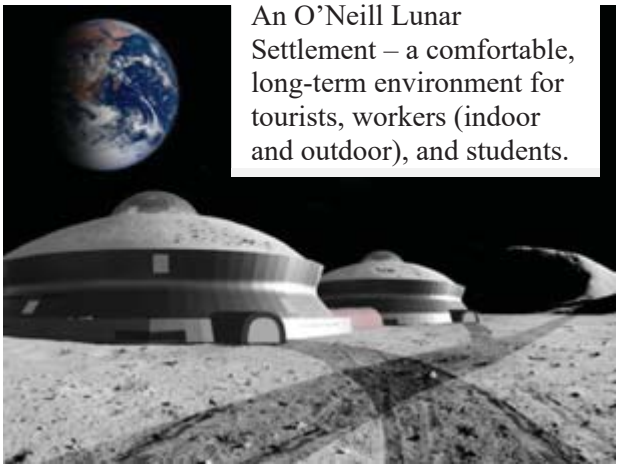
The big screen lights up. "Hello. I'm Julie Wellman and I'm a graduate student at the University of Southern California working in the brand new and exciting field of gravitational biology here near the south pole of the Moon. The terrain here is over 100 million years old and is pretty rugged, but it's no problem for my all-electric Ford Luna. Gas would be a bit pricy here on the Moon, but my Luna uses only electricity and is pretty stingy on that. Enjoy the halftime show. I'll check in later to show you how the Luna works in this terrain."

USC graduate student on the Moon

Course project for Spring 2023

Recent research suggests that we should be able to create a profitable income-generating lunar settlement that would allow us to live, work, and vacation on the Moon in the next 5 to 10 years. Income would be in the range of $5B to $10B per year in the near term, rising to $100B per year as the settlement grows. Development is predominantly commercial and does not require the creation of any major new technology.

The course will critically explore that concept in some detail. We will look closely at both cost and income, and also at legal, social, economic, business, and political issues.



An O'Neill Lunar Settlement – a comfortable, long-term environment for tourists, workers (indoor and outdoor), and students.

In the not-too-distant future, one or more of the folks who have taken the course, or possibly someone that works with you or for you (or is you), could be living and working on the Moon for several months or a year or two. We will look closely at whether this is, or could become, real.

Representative Topics:

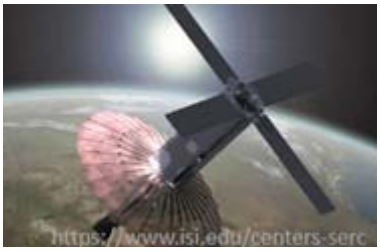
Why aren't we there yet?	Background	What can be done in the near-term?
Creating income	Making a commercial activity	Legal issues
Architecture and structures	Government	Business Plan and Marketing
Areas of graduate student participation	Reducing cost	Maintaining Safety
Economic models of cost vs. income	Human vs robotic missions	Education – teaching Earth

No required textbook. Course notes and some recommended reading.

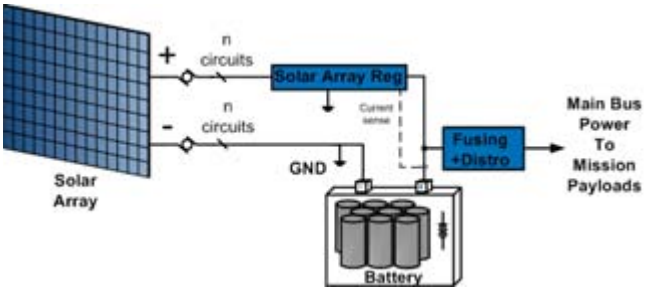
Instructor: Prof. James Wertz, Microcosm, jwertz@smad.com

ASTE 584 *Spacecraft Power Systems*

Spring 2023

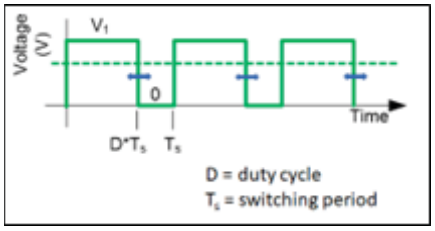


Engineering fundamentals and system design concepts necessary to power a spacecraft. Learn how to "keep the lights on" in the challenging space environment, from energy collection and storage, to power conversion, to distribution and fault management. Explore theory of operation for solar arrays, batteries, fuel cells, nuclear power sources, power conversion electronics, and power distribution systems. Learn concepts of power system stability and power quality for payloads. Explore overall power system architecture and how to size a power system. Gain insight on design process, analysis techniques, and verification methods. Understand practical design considerations for space, cost/reliability/performance trades, and design optimization.



Topics:

- Power system requirements
- Space environment + orbits, effects on the power system
- Solar cells and solar arrays
- Battery cells, batteries, fuel cells
- Radioisotope and nuclear dynamic sources
- Power processing and conditioning
  - ➢ Direct energy transfer
  - ➢ Switchmode power conversion
- Fusing, distribution, grounding, power quality, stability
- Worst case analysis, thermal, reliability, redundancy, qualification
- Overall electrical power system architecture and system optimization
- Integration, testing, and on-orbit operations



Reading material:

Course is primarily taught from lecture slides.
Supplementary reading: A.K. Hyder et al., Spacecraft Power Technologies, Icp, 2000/3 or
M.R. Patel, Spacecraft Power Systems, CRC, 2004

Instructors: Steve Lapen and David E. Lee (Northrop Grumman Corp.)

Space industry professionals with practical experience spanning multiple space mission design cycles from conceptual studies, to detailed design, to flight hardware production, to integration & test, to on-orbit operations.

Questions to instructors: contact ASTE Student Services Director Luis Saballos.

Instructors of *Astronautics* courses in Spring 2023 (alphabetically)

Prof. David Barnhart (ASTE and ISI; University of Southern California)

ASTE 566
Ground Communications for Satellite Operations

Prof. Gerald Hintz (The Aerospace Corp.) Lead instructor

ASTE 683
Advanced Spacecraft Navigation

Dr. Lubos Brieda (PIC-C)

ASTE 546
Computational Plasma Dynamics

Dr. Michael Kezirian (IAASS)

ASTE 599
Safety of Space Systems and Space Missions

Prof. Don Edberg (Cal Poly Pomona)

ASTE 574
Space Launch Vehicle Design

Steve Lapen (Northrop Grumman)

Co-Instructor
ASTE 584
Spacecraft Power Systems

Prof. Keith Goodfellow (LM Aerojet Rocketdyne)

ASTE 572
Advanced Spacecraft Propulsion

Dr. David E. Lee (Northrop Grumman)

Co-Instructor
ASTE 584
Spacecraft Power Systems

Prof. Mike Gruntman (Univ. of Southern California)

ASTE 575
Rocket and Spacecraft Propulsion

Prof. Ryan Park (JPL)

ASTE 581
Orbital Mechanics II

Prof. Gerald Hintz (The Aerospace Corp.)

ASTE 580
Orbital Mechanics

Dr. G. P. Purohit (The Aerospace Corp.)

ASTE 570
Liquid Rocket Propulsion

Instructors of *Astronautics* courses in Spring 2023 (alphabetically; cont.)

Prof. Kent Tobiska
(Space Environm. Techn.)

ASTE 535
Space Environments and Spacecraft Interactions

Prof. James Wertz
(Microcosm)

ASTE 523
Design of Low Cost Space Missions

Prof. Garrett Reisman
(Univ. of Southern California

ASTE 562
Spacecraft Life Support Systems

University of Southern California

Department of Astronautical Engineering (ASTE)

Astronautics Classes offered in the spring semester, 2023

Core Requirements

ASTE 535 (3) – Space Environment and SC Interactions — DEN-webcast
Instructor: **Prof. Kent Tobiska** (Space Environment Technologies)

ASTE 575 (3) – Rocket and Spacecraft Propulsion — DEN-webcast
Instructor: **Prof. Mike Gruntman** (USC)

ASTE 580 (3) – Orbital Mechanics I — DEN-webcast
Instructor: **Prof. Gerald Hintz** (Aerospace Corp.)

Core Elective and Elective Requirements

ASTE 523 (3) – Design of Low Cost Space Missions
Instructor: **Prof. James Wertz** (Microcosm) — DEN-webcast

ASTE 529 (3) – Safety of Space Systems & Space Missions — DEN-webcast only
Instructor: **Prof. Michael Kezirian** (IAASS)

ASTE 546 (3) – Computational Plasma Dynamics
Instructor: **Dr. Lubos Brieda** (PIC-C) — DEN-webcast

ASTE 562 (3) – Spacecraft Life Support Systems
Instructor: **Prof. Garrett Reisman** (USC) — DEN-webcast

ASTE 566 (3) – Ground Communications for Satellite Operations
Instructor: **Prof. David Barnhart** (USC) — on campus and DEN
limited enrollment (6 on-campus and 6 DEN students)

ASTE 570 (3) – Liquid Rocket Propulsion — DEN-webcast
Instructor: **Dr. G. P. Purohit** (Aerospace Corp.)

ASTE 572 (3) – Advanced Spacecraft Propulsion — DEN-webcast only
Instructor: **Prof. Keith Goodfellow** (LM Aerojet Rocketdyne)

ASTE 574 (3) – Space Launch Vehicle Design — DEN-webcast
Instructor: **Prof. Don Edberg** (Cal Poly Pomona)

ASTE 581 (3) – Orbital Mechanics II — DEN-webcast
Instructor: **Prof. Ryan Park** (JPL)

ASTE 584 (3) – Spacecraft Power Systems — DEN-webcast
Instructors: **Drs. Steve Lapen and David E. Lee** (NGC)

ASTE 683 (3) – Advanced Spacecraft Navigation — DEN-webcast
Instructor (lead): **Prof. Gerald Hintz** (The Aerospace Corp.)

The schedule is preliminary – always check with the student adviser. For more information on the *Master of Science* degree program in *Astronautical Engineering* (MS ASTE) please check http://gapp.usc.edu/graduate-programs/masters/astronautical-engineering and contact ASTE Student Services Director Mr. Luis Saballos (tel. 213–821–4234; lsaballo@usc.edu).
MS ASTE Frequently Asked Questions are at http://astronauticsnow.com/msaste/faq.html.

University of Southern California

Department of Astronautical Engineering (ASTE)

Astronautics Classes offered in the summer semester, 2023

Required courses

ASTE 580 (3) –	Orbital Mechanics I	DEN-webcast
Instructor:	**Prof. Ryan Park** (JPL)	

Prof. Ryan Park
(Jet Propulsion Laboratory)

ASTE 580
Orbital Mechanics I

The schedule is preliminary – always check with the student adviser. For more information on the *Master of Science* in *Astronautical Engineering* (MS ASTE) program please check https://viterbigradadmission.usc.edu/programs/masters/msprograms/astronautical-engineering/ and contact ASTE Senior Administrator Ms. Dell Cuason (OHE–500U; tel. 213–821–5817; cuason@usc.edu) or ASTE Student Services Director Mr. Luis Saballos (OHE–500Q; tel. 213–821–4234; lsaballo@usc.edu).

MS ASTE Frequently Asked Questions are at http://astronauticsnow.com/msaste/faq.html.

Instructors of *Astronautics* courses in Fall 2023 (alphabetically)

University of Southern California

Dr. Mohamed Abid
(Jet Propulsion Laboratory)

ASTE 554
Spacecraft Sensors

Dr. G. P. Purohit
(The Aerospace Corp.)

ASTE 552
Spacecraft Thermal Control

Prof. David Barnhart (ASTE and ISI; University of Southern California)

ASTE 566
Ground Communications for Satellite Operations

Prof. Garrett Reisman
(Univ. of Southern California)

ASTE 524 *Human Spaceflight*

Prof. Mike Gruntman
(Univ. of Southern California)

ASTE 520
Spacecraft Systems Design

Prof. Garrett Reisman
(Univ. of Southern California)

ASTE 561 *Human Factors of Spacecraft Operations*

Prof. Gerald Hintz
(The Aerospace Corp.)

ASTE 583
Space Navigation: Theory and Practice

Prof. Anita Sengupta
(Hyperloop)

ASTE 577
Entry and Landing Systems for Planetary Exploration

Dr. Leila Meshkat
(Jet Propulsion Laboratory)

ASTE 528
Reliability of Space Systems

Madhu Thangavelu
(AAA Visioneering)

ASTE 527
Space Exploration Architectures Concept Studio

Instructors of *Astronautics* courses in Fall 2023 (alphabetically; cont.)

Prof. Kent Tobiska
(Space Environment Technologies)

ASTE 535
Space Environments and Spacecraft Interactions

Dr. Brett Willams
(Boeing/Facebook)

ASTE 556
Spacecraft Structural Materials

Prof. Ryan Park
(Jet Propulsion Laboratory)

ASTE 580
Orbital Mechanics I

Prof. Joseph Wang
(Univ. of Southern California)

ASTE 505a
Plasma Dynamics

University of Southern California

Department of Astronautical Engineering (ASTE)

Astronautics Classes offered in the fall semester, 2023

Core Requirements

ASTE 520 (3)	–	Spacecraft System Design	DEN-webcast
Instructor:		**Prof. Mike Gruntman** (USC)	
ASTE 535 (3)	–	Space Environment and SC Interactions	DEN-webcast
Instructor:		**Dr. Kent W. Tobiska** (Space Environment Techn.)	
ASTE 580 (3)	–	Orbital Mechanics I	DEN-webcast
Instructor:		**Prof. Ryan Park** (JPL)	

Core Elective and Elective Requirements

ASTE 505a (3)	–	Plasma Dynamics I	on-campus only
Instructor:		**Prof. Joseph Wang** (USC)	
ASTE 524 (3)	–	Human Spaceflight	DEN-webcast
Instructor:		**Prof. Garrett Reisman** (USC)	
ASTE 527 (3)	–	Space Exploration Architectures Concept Studio	DEN-webcast
Instructor:		**Madhu Thangavelu** (AAA Visioneering) limited enrollment (6 on-campus + 6 online)	
ASTE 528 (3)	–	Reliability of Space Systems	DEN-webcast
Instructor:		**Dr. Leila Meshkat** (JPL.)	
ASTE 552 (3)	–	Spacecraft Thermal Control	DEN-webcast
Instructor:		**Dr. G.P. Purohit** (Aerospace Corp.)	
ASTE 554 (3)	–	Spacecraft Sensors	DEN-webcast
Instructor:		**Dr. Mohamed Abid** (JPL)	
ASTE 557 (3)	–	Spacecraft Structural Strength and Materials	DEN only
Instructor:		**Dr. Robert Williams** (Boeing/Facebook)	
ASTE 561 (3)	–	Human Factors of Spacecraft Operations	DEN-webcast
Instructor:		**Prof. Garrett Reisman** (USC) limited enrl (11 on-campus + 10 online)	
ASTE 566 (3)	–	Ground Communications for Sat. Ops	on campus and DEN
Instructor:		**Prof. David Barnhart** (USC) limited enrollm (6 on-campus + 6 online)	
ASTE 577 (3)	–	Entry and Landing Systems for Planetary Exploration	
Instructor:		**Prof. Anita Sengupta** (Hyperloop)	DEN-webcast
ASTE 583 (3)	–	Space Navigation: Theory and Practice	
Instructor:		**Prof. Gerald Hintz** (Aerospace Corp.)	DEN-webcast

The schedule is preliminary – always check with the student adviser. For more information on the *Master of Science* degree program in *Astronautical Engineering* (MS ASTE) please check http://gapp.usc.edu/graduate-programs/masters/astronautical-engineering and contact ASTE Student Services Director Mr. Luis Saballos (tel. 213–821–4234; lsaballo@usc.edu)

MS ASTE Frequently Asked Questions are at http://astronauticsnow.com/msaste/faq.html.

Preliminary Astronautics Class Schedule (as of Oct 2022)

(subject to change – always check with *ASTE Student Adviser*)

					2022	2023	2023	2024	2024	2025	2026	2026
Required Courses					Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring
ASTE 520	Spacecraft Design	1	D	R	▼		▼		▼		▼	
ASTE 535	Space Environment and Spacecraft Interactions	2	D	R	▼	▼	▼	▼	▼	▼	▼	▼
ASTE 580	Orbital Mechanics I	2	D	R	▼	▼	▼	▼	▼	▼	▼	▼
	Orbital Mechanics I		D	R	also offered in summers -- see next page							
ASTE 470*	Spacecraft Propulsion	1	D	R	▼			see next page				
ASTE 575*	Rocket and SC Propulsion	1	D	R		▼		▼		▼		▼
Elective Courses												
ASTE 501a	Physical Gas Dynamics I	Ir	N	C			tbc		tbc		tbc	
ASTE 505ab	Plasma Dynamics I, II	1#	N	C			a	b	a		a	B
ASTE 523	Design Low Cost Sp Missions	#	D	C		▼				▼		
ASTE 524	Human Spaceflight	1	D	C	▼		▼		▼		▼	
ASTE 527	Space Studio Architecting	1	D	C	▼		▼		▼		▼	
ASTE 528	Reliability of Space Systems	#	D	C			▼				▼	
ASTE 529	Safety Space Sys. & Missions	#	D	C		▼				▼		
ASTE 546	Comp. Plasma Dynamics	#	N	E		▼				▼		
ASTE 552	Spacecraft Thermal Control	#	D	C			▼				▼	
ASTE 553	Sys Remote Sensing Space	#	D	C	▼				▼			
ASTE 554	Spacecraft Sensors	#	D	C			▼				▼	
ASTE 555	Space Cryogenic Sys & Applic	#	D	C	see next page							
ASTE 556	SC Structural Dynamics	#	D	C	▼				▼			
ASTE 557	SC Structural Materials	#	D	C			▼					
ASTE 561	Human Factors Spacecraft Ops	1	D	C	▼		▼		▼		▼	
ASTE 562	Spacecraft Life Support Sys	1	D	C		▼		▼		▼		▼
ASTE 566	Ground Comm Satellite Ops	1	N	C		▼	▼	▼	▼	▼	▼	▼
ASTE 570	Liquid Rocket Propulsion	1	D	C		▼		▼		▼		▼
ASTE 571	Solid Rocket Propulsion	#	D	C	▼				▼			
ASTE 572	Advanced SC Propulsion	1	D	C		▼		▼		▼		▼
ASTE 574	Space Launch Vehicle Design	1	D	C		▼		▼		▼		▼
ASTE 577	Entry & Landing Planet. Sys.	1	D	C	▼		▼		▼		▼	
ASTE 581	Orbital Mechanics II	1	D	C		▼		▼		▼		▼
ASTE 583	Space Navigation	#	D	C			▼				▼	
ASTE 584	SC Power Systems	1	D	C		▼		▼		▼		▼
ASTE 585	SC Attitude Control	1	D	C		offered in summers -- see next page						
ASTE 586	SC Attitude Dynamics	#	D	C				▼				▼
ASTE 589	Solar System Navigation	#	D	C	▼				▼			
ASTE 599	Safety of Space Operations	#	D	E				▼				▼
ASTE 599	to be announced			E								
ASTE 683	Adv. Spacecraft Navigation	Ir	D	E		▼				▼		

*ASTE 575 and ASTE 575 --- see the next page

Required course in spacecraft propulsion

The required ASTE-470 is not available for graduate credit anymore.

It has been replaced by ASTE-575 which is required for MS ASTE and is identical to ASTE-470. (ASTE-575 duplicates the credit for ASTE-470).

Graduate students pursuing MS ASTE are required from now on to take ASTE-575.

This Fall 2022, ASTE-470 was open to undergraduate students only. For Master's students, special permission was needed to take ASTE-470.

Courses in summer

Required Courses					2023 summer	2024 summer	2025 summer	2026 summer
ASTE 580	Orbital Mechanics I	2	D	R	▼	▼	▼	▼
Elective Courses								
ASTE 585	Spacecraft Attitude Control	1	D	C		▼ tbc	▼ tbc	▼ tbc

Courses listed but not offered (due to availability of instructors)

Elective Courses												
ASTE 501a	Physical Gas Dynamics I	Ir	N	C	We may be able to offer the course in Fall 2023							
ASTE 555	Space Cryogenic Sys & Applic	#	D	C								
ASTE 584	SC Power Systems	1	D	C	We plan to offer ASTE-584 annually from spring 2023							

Table notation

SC = spacecraft

2 = course offered in both fall and spring each year

1 = course offered each year

= course offered every second year

Ir = course offered irregularly

▼ = planned (subject to School approval)

R = required MS ASTE

C = core elective MS ASTE

E = technical elective

D = webcast through DEN

N = on campus; not available through DEN

? = uncertain, check with ASTE Student Adviser

tbc = to be confirmed

The course schedule is subject to change. Please check with ASTE Student Advisor.

Master of Science in Astronautical Engineering

This degree is in the highly dynamic and technologically advanced area of astronautics and space technology. The program is designed for those with B.S. degrees in science and engineering who work or wish to work in the space sector of the defense/aerospace industry, government research and development centers and laboratories and academia. The program is available through the USC Distance Education Network (DEN).

The general portion of the Graduate Record Examinations (GRE) and two letters of recommendation are required.

Required courses: 27 units

CORE REQUIREMENT (12 units)		**Units**
ASET 575	Spacecraft Propulsion	3
ASTE 520	Spacecraft System Design	3
ASTE 535	Space Environment and Spacecraft Interactions	3
ASTE 580	Orbital Mechanics I	3

CORE ELECTIVE REQUIREMENT (9 units - choose three courses)		**Units**
ASTE 501ab	Physical Gas Dynamics	3-3
ASTE 505ab	Plasma Dynamics	3-3
ASTE 523	Design of Low Cost Space Missions	3
ASTE 524	Human Spaceflight	3
ASTE 527	Space Exploration Architectures Studio	3
ASTE 528	Reliability of Space Systems	3
ASTE 529	Safety of Space Systems and Space Missions	3
ASTE 552	Spacecraft Thermal Control	3
ASTE 553	Systems for Remote Sensing from Space	3
ASTE 554	Spacecraft Sensors	3
ASTE 555	Space Cryogenic Systems and Applications	3
ASTE 556	Spacecraft Structural Dynamics	3
ASTE 557	Spacecraft Structural Strength and Materials	3
ASTE 561	Human Factors of Spacecraft Operations	3
ASTE 562	Spacecraft Life Support Systems	3
ASTE 566	Ground Communications for Satellite Operations	3
ASTE 570	Liquid Rocket Propulsion	3
ASTE 571	Solid Rocket Propulsion	3
ASTE 572	Advanced Spacecraft Propulsion	3
ASTE 574	Space Launch Vehicle Design	3
ASTE 577	Entry and Landing Systems for Planetary Surface Exploration	3
ASTE 581	Orbital Mechanics II	3
ASTE 583	Space Navigation: Principles and Practice	3

ASTE 584	Spacecraft Power Systems	3
ASTE 585	Spacecraft Attitude Control	3
ASTE 586	Spacecraft Attitude Dynamics	3
ASTE 589	Solar System Navigation	3

TECHNICAL ELECTIVE REQUIREMENT (6 Units)

Two 3-unit courses. Students are advised to select these two elective courses from the list of core electives or from other courses in astronautical engineering or from other science and engineering graduate courses, as approved by the faculty adviser. No more than 3 units of directed research (ASTE 590) can be applied to the 27-unit requirement. New courses on emerging space technologies are often offered; consult the current semester's course offerings, particularly for ASTE 599 Special Topics.

At least 21 units must be at the 500 or 600 level.

Areas of concentration:

Students choose core elective and technical elective courses that best meet their educational objectives. Students can also concentrate their studies in the desired areas by selecting corresponding core elective courses. Presently, ASTE faculty suggests the following areas of concentration:

Spacecraft propulsion Choose two core electives from

ASTE 501ab	Physical Gas Dynamics	3-3
ASTE 505a	Plasma Dynamics	3
ASTE 570	Liquid Rocket Propulsion	3
ASTE 571	Solid Rocket Propulsion	3
ASTE 572	Advanced Spacecraft Propulsion	3
ASTE 574	Space Launch Vehicle Design	3
ASTE 584	Spacecraft Power Systems	3

Spacecraft dynamics Choose two core electives from

ASTE 556	Spacecraft Structural Dynamics	3
ASTE 557	Spacecraft Structural Strength and Materials	3
ASTE 581	Orbital Mechanics II	3
ASTE 583	Space Navigation: Principles and Practice	3
ASTE 585	Spacecraft Attitude Control	3
ASTE 586	Spacecraft Attitude Dynamics	3
ASTE 589	Solar System Navigation	3

Space system design Choose two core electives from

ASTE 523	Design of Low Cost Space Missions	3
ASTE 524	Human Spaceflight	3
ASTE 527	Space Exploration Architectures Studio	3
ASTE 528	Reliability of Space Systems	3
ASTE 529	Safety of Space Systems and Space Missions	3

ASTE 557	Spacecraft Structural Strength and Materials	3
ASTE 562	Spacecraft Life Support Systems	3
ASTE 574	Space Launch Vehicle Design	3
ASTE 577	Entry and Landing Systems for Planetary Surface Exploration	3

Spacecraft systems and operations

Choose two core electives from

ASTE 524	Human Spaceflight	3
ASTE 529	Safety of Space Systems and Space Missions	3
ASTE 552	Spacecraft Thermal Control	3
ASTE 553	Systems for Remote Sensing from Space	3
ASTE 554	Spacecraft Sensors	3
ASTE 555	Space Cryogenic Systems and Applications	3
ASTE 561	Human Factors of Spacecraft Operations	3
ASTE 562	Spacecraft Life Support Systems	3
ASTE 566	Ground Communications for Satellite Operations	3
ASTE 584	Spacecraft Power Systems	3

Space applications Choose two core electives from

ASTE 524	Human Spaceflight	3
ASTE 527	Space Exploration Architectures Studio	3
ASTE 553	Systems for Remote Sensing from Space	3
ASTE 554	Spacecraft Sensors	3
ASTE 555	Space Cryogenic Systems and Applications	3

Safety of Space Systems Choose two core electives from

ASTE 528	Reliability of Space Systems	3
ASTE 529	Safety of Space Systems and Space Missions	3
ASTE 561	Human Factors of Spacecraft Operations	3

Human Space Flight Choose two core electives from

ASTE 524	Human Spaceflight	3
ASTE 529	Safety of Space Systems and Space Missions	3
ASTE 561	Human Factors of Spacecraft Operations	3
ASTE 562	Spacecraft Life Support Systems	3

Note to students:

Please note that tracks, or areas of specialization (concentration), within the program do not appear in transcripts or have separate post-codes. Faculty uses tracks in advising students on different routes to the degrees meeting their educational objectives. The tracks are usually listed in the catalog to help describe the program to prospective students.

Admission Requirements for Graduate Degrees

in *Astronautical Engineering* – Code ASTE

The Department of Astronautical Engineering (ASTE) of the **USC Viterbi School of Engineering** offers degrees in **astronautical engineering**, code **ASTE**. The admission to the Master of Science degree program (MS ASTE) is based on the totality of the applicant's record which includes GPA, GRE, and two letters of recommendation.

Required items:	Send To
Application	Office of Grad. and Int'l Admission
Official Transcript(s)	Office of Grad. and Int'l Admission
General Record Exam	Office of Grad. and Int'l Admission
TOEFL (international students only)	Office of Grad. and Int'l Admission
Financial Statement	Office of Grad. and Int'l Admission
Recommendation Letters	Office of Grad. and Int'l Admission

Application

All applications should be submitted online at http://www.usc.edu/admission/graduate/apply/

Official Transcript(s)

The University requires official transcripts from the accredited colleges or universities the applicant has attended. The MS Degree Program in Astronautical Engineering (Code ASTE) requires a minimum GPA of 3.0.

USC now accepts official electronic transcripts, provided they meet the following guidelines:

1. The transcript originates from a secure site formally linked to the sending institution.

2. The school is located in the United States. We do not accept electronic transcripts from any institution overseas.

General Record Exam

The Department of Astronautical Engineering requires the general GRE. The GRE must be taken within five years of the application date. USC's ETS school code is 4852. Applicants taking the GRE should use this code to ensure the official submission of test scores.

English Language Proficiency for International Applicants

In addition to the general admission criteria listed above, international students whose first language is not English are required to take the TOEFL or IELTS examination to be considered a candidate for admission. There is no minimum TOEFL or IELTS score required for admission to the Viterbi School. For possible exemption from additional language requirements, you must achieve an Internet Based TOEFL (iBT) score of 90, with no less than 20 on each section, or an IELTS score of 6.5, with no less than 6 on each band score.

For more details on English Proficiency Criteria for the University of Southern California, please visit https://www.usc.edu/admission/graduate/international/englishproficiency.html.

Recommendation Letters

Please provide two professional letters of reference (former instructors, supervisors, professional colleagues, advisers, etc.) to be filed through the online application process.

Mailing addresses, if needed

Office of Graduate and International Admission
University of Southern California
3601 S. Flower St, Room 112
Los Angeles, CA 90089-0915

Department of Astronautical Engineering
ASTE Graduate Program, 3650 McClintock Ave, OHE-500
University of Southern California
Los Angeles, CA 90089-1451

Department Application deadline

15 January for fall; 1 October for spring; 1 February for summer.

Please note that verification and processing of materials by the Office of Graduate and International Admission may take four to six weeks.

Limited Status Enrollment

Limited enrollment is to provide strong candidates for admission the opportunity to get started, without having to wait for the next admissions cycle. Strong candidacy is indicated by a B.S. in engineering or science from a regionally accredited institution with a GPA of 3.0 or above. Students who do not meet these standards must apply for admission where their GPA, transcripts, GRE scores, and letters of recommendation will be evaluated by admissions officers and faculty.

Limited-status students can take up to three (3) courses. These courses will be credited, after formal admission to the program, toward the Master's degree in Astronautical Engineering (MS ASTE).

Students who are interested in pursuing a graduate degree should not delay their application. We have many limited-status students in the program.

Admission

Admission decisions are based on the totality of the applicants' records, including academic performance, test scores, letters of recommendation, and other supporting materials. Applicants will be notified once an admission decision has been reached. Admitted applicants will receive further information about advisement, housing, orientations, and campus tour.

Conditional Admission

Applicants who do not meet admission qualifications may be granted conditional admission. Conditionally admitted students will be notified in writing of their admission status and of the conditions which must be satisfied to gain regular student status. Students must satisfy the admission conditions typically during the first semester of study.

Other Questions:

Please contact ASTE Senior Administrator Ms. Dell Cuason (OHE-500U; tel. 213–821–5817; cuason@usc.edu) and ASTE Student Services Director Mr. Luis Saballos (OHE-500Q; tel. 213–821–4234; lsaballo@usc.edu) and visit http://astronautics.usc.edu.

Student Transfer to Degrees

in Astronautical Engineering – Code ASTE

Transfer Process – Viterbi Engineering Students

Please refer to the VSOE change of major form and contact ASTE Student Services Director Mr. Luis Saballos (OHE-500Q; tel. 213–821–4234; lsaballo@usc.edu) for further details of the process.

Transfer Process – Non-Engineering Students

Transfer to a program in Astronautical Engineering, Code ASTE, requires a non-engineering student to file the USC application for graduate admission to the program in Astronautical Engineering. Processing of the application does not require re-submission of supporting documents (e.g., transcripts) that have been previously submitted to USC. Check with ASTE Student Services Director Mr. Luis Saballos (OHE-500Q; tel. 213–821–4234; lsaballo@usc.edu).

Restrictions

Transfer to a program in Astronautical Engineering, Code ASTE, cannot be requested during the first semester of student studies at USC.

Questions?

Please contact ASTE Senior Administrator Ms. Dell Cuason (OHE-500U; tel. 213–821–5817; cuason@usc.edu).

GPA, Leave of Absence, and Graduation

Grade Point Average

Students must maintain an overall 3.0 GPA on 400-level and above work attempted at USC beyond the bachelor's degree to graduate. A minimum grade of C (2.0) is required in a course to receive graduate credit. Transfer units count as credit (CR) and are not calculated in the GPA.

Leave of Absence

There are times students suspend their studies for a semester due to heavy workload or personal matters. Students must file for leave of absence within the department, and withdraw from classes before the last day to drop classes without a mark of W (see in the Schedule of Classes). Students who miss the deadline for LOA may still withdraw from classes with a mark of W but must apply for readmission to the program.

Graduation

At the beginning of the last semester, students should file an Application for a Master's Degree and contact the Student Affairs staff. This will initiate the degree check process, verifying that all academic and administrative requirements are met.

Questions?

Please contact ASTE Senior Administrator Ms. Dell Cuason (OHE-500U; tel. 213–821–5817; cuason@usc.edu) and visit http://astronautics.usc.edu.