November 8, 2015

To: Graduate 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) During the last academic year the Viterbi School celebrated the 10th anniversary of the Department of Astronautical Engineering (ASTE) at USC (see pages 3, 4).

From humble beginning and in a record short period of time, we have grown into a major nationally-recognized Department. The flagship Master of Science (MS) degree program reaches students all over across the United States and Canada as well as at military installations at home (p. 8) and abroad. We awarded 396 Master of Science ASTE degrees from 2004–2015; during the last 10 years, it was on average 37+ Master’s degrees annually (p 5).

2) This summer we modified the MS degree requirements to reflect the program growth. The new requirements are in the updated USC catalog (see pp. 23, 24).

3) ASTE’s Ad Astra Student Society (AdA).
   Please contact Society President Roderic Vanderscoff (rvanders@usc.edu) to learn about AdA programs and how to get involved.

4) USC Astronautics Alumni, Students, Faculty, and Friends.
   This professional networking group on LinkedIn was established six years ago and it has more than 600 members now.

   See http://astronauticsnow.com/astrousclinkedin/.

We welcome not only our current ASTE students and alumni but also other USC students who took Astronautics graduate courses as well as friends and supporters of the program from industry, government centers, and space advocacy groups.

5) This newsletter provides program news, long-term course schedule, and other information about coursework of interest to our past, current, and future students. Please always check with ASTE Student Advisor the near-term course schedule.
5) Meet ASTE staff (photo on the right). Certainly, do not hesitate contacting Astronautics Senior Administrator Ms. Dell Cuason (RRB-225; tel. 213-821-5817; cuason@usc.edu) should you have any questions about the program. ASTE Student Advisor Ms. Norma Perry (RRB-223; tel. 213-821-4234; norduna@usc.edu) is your first contact on questions regarding class registration, schedule, and admission to the programs in astronautical engineering. Ms. Linda Ly (RRB-230; tel. 213-740-7228; lylinda@usc.edu) supports business operations of the department and research grants and contracts of the faculty.

Before your inquiries, check the web site of the MS ASTE frequently asked questions at http://astronauticsnow.com/msaste/faq.html.

6) Please find below
   (a) ASTE founding (pp. 3, 4) and MS ASTE statistics (p.5)
   (b) ASTE program, student, and faculty news (pp. 6-11)
   (c) astronaut requirements and application details (p. 12)
   (d) student resources – The Space Show (p. 13)
   (d) information on program classes in Spring, Summer, and Fall semesters of 2016 (pp. 14-21)
   (e) preliminary long-term class schedule for (pages 22)
   (f) catalog description of MS ASTE (pages 23, 24)
   (g) admission requirements, transfer to graduate degrees in Astronautical Engineering, GPA, leave of absence, and graduation (pages 25-28)

Ad Astra!

Mike Gruntman
Professor of Astronautics
Director, MS in Astronautical Engineering

Do you know how many Trojan astronauts were in space?

See http://astronauticsnow.com/uscastronauts/
The University of Southern California established the new Department first as the Astronautics and Space Technology Division on August 13, 2004. From the day one, the new academic unit operated as an independent department and introduced the full set of degree programs in Astronautical Engineering. The University formally renamed it the Department of Astronautical Engineering in 2010.

In his memo (left) in 2004, then Dean of Engineering, and now USC President, Prof. Max Nikias wrote:

In order to position the USC Viterbi School of Engineering to take full advantage of rapidly growing opportunities in space, I am today announcing the creation of a new Astronautics and Space Technology Division. Following the drastic funding cutbacks in the early 1990s, space technology and astronautics has recently re-emerged as an important sector of economic and engineering activity not only in the Southern California economy but also in the nation as a whole. Both national security applications and space exploration are driving this resurgence.

I am pleased to appoint Professor Mike Gruntman as chair of the Astronautics and Space Technology Division effective August 13, 2004 for a three-year term. Professor Joseph Kunc and Professor Daniel Erwin will join him as faculty in the division. Professor Stan Settles of the ISE Department and Professor Peter Will and Dr. Joseph Sullivan, from the Information Sciences Institute (ISI), will have secondary faculty appointments in the ASTD...

On the occasion of the 10th anniversary of the Department of Astronautical Engineering, USC President Prof. Max Nikias met with Astronautics faculty and staff on January 13, 2015.

In the President’s office: left-to-right USC President Max Nikias, Professor Mike Gruntman, Professor Joseph Wang, Professor Joseph Kunc, Ms. Dell Cuason (who had served from the early days of ASTE as its business manager), Professor Daniel Erwin, Dean of Engineering Yannis Yortsos.

Viterbi School of Engineering hosted a reception for USC faculty, staff, students, and guests celebrating the 10th anniversary of ASTE on March 26, 2015.
MS ASTE – Statistics

The Department of Astronautical Engineering continues its steady growth.

We are reaching students all over across the United States and Canada as well as at military installations at home and abroad.

During the last 10 academic years, we awarded – on average – more than 37 Master’s degrees annually.

- National statistics (American Society of Engineering Education – ASEE) combines students in astronautical, aeronautical, and aerospace engineering in one broad group (>65 departments in the United States)
- In AY 2011–2012, USC MS ASTE program accounted for 2.7% of national enrollment in this broad aerospace/astronautical/aeronautical group

396 MS ASTE degrees awarded from 2004-2015; on average 37+ annually during last 10 academic years

3.3% nationally awarded Master’s degrees in astronautical/aeronautical/aerospace engineering

Among students working full-time and studying part-time in academic year 2011-2012 (available statistics), USC MS ASTE program accounted for 6.6% of national enrollment of astronautics/aeronautical/aerospace students.

>1260 students enrolled in ASTE-520 during the last 12 years (since 1996)
PhD Program in Astronautics

PhD Degrees in Astronautical Engineering (ASTE) Awarded in 2014–2015 Academic Year

Daoru Han
Dissertation Title:
Particle-in-Cell Simulations of Plasma Interactions with Asteroidal and Lunar Surfaces

Thada Suksila
Dissertation Title:
Cathode Plasma Simulation

Seth Wieman
Dissertation Title:
Revised Calibration of a Long Term Solar Extreme Ultraviolet Irradiance Data Set

Academic year
2014–2015

Astronautical Engineering PhDs

Thada Suksila
Seth Wieman
Daoru Han
Professor Joseph Kunc who had directed the PhD program of the ASTE Department since its creation in 2004 stepped down to concentrate on other tasks. Professor Joseph Wang has assumed responsibilities of Advisor of the ASTE PhD Program.

Under the leadership of Professor Kunc, a large number of students earned their doctorate degrees. The figure below shows some recent recipients of PhD degrees as highlighted in this newsletter in the past.
Since its founding, the Master of Science program in Astronautical Engineering MS ASTE always had students serving in the armed forces. Many of them took classes through the Distance Education Network while being stationed across the United States as well as at such far away locations as Thule in Greenland and Germany.

Many active-duty officers pursue degrees in astronautical engineering in order to find interesting and exciting employment in space industry and government centers after retiring from service. Similarly to some our civilian students, a few also consider applying for astronaut training.

The figure below shows two accomplished pilots and our students at Ellington Field in Houston, with NASA's T-38 behind. On the left is David Smith, who served at various assignments in the Marine Corps and the Pentagon. He successfully completed the program and received his MS ASTE degree. Recently, Dave retired from the armed forces and joined the Johnson Space Center at NASA. And he enjoys the new job!

Our current student Will Pressley is on the right. He is a U.S. Navy EA-18G squadron commander stationed in the State of Washington. Commander Pressley (yes, Commander, as in Commander Bond) is on track to achieve the degree in Astronautical Engineering.

As Professor Hintz explains in the preface,

“This book is based on my work as an engineer and functional manager for 37 years at NASA’s Jet Propulsion Laboratory (JPL) and my teaching experience with graduate-level courses in Astronautical Engineering at the University of Southern California (USC).”

Many Astronautics alumni and current students took courses with Professor Hintz who had been lecturing at USC since 1979.

The American Institute of Aeronautics and Astronautics (AIAA) published a new book by ASTE Professor Mike Gruntman *Intercept 1961. The Birth of Soviet Missile Defense.* This is Mike’s fourth book (and the third one on rocketry and space).

More than 50 years ago, pioneering scientists and engineers in the Soviet Union and the United States searched for a technical means of defense against ballistic missiles. This book tells the little-known story of the earliest breakthroughs which paved the way for the emergence of missile defense, a major factor in the Cold War.

This historical background is critical for informed policy formulation, threat evaluation, defense planning, and counteracting the proliferation of weapons and sensitive technologies. The book is a must read for students of history, scientists and engineers, analysts, and specialists in international relations and national security.

The recent issue (October 26, 2015) of *Space News* highlighted a lifelong pursuit of ASTE Professor James Wertz (figure, bottom) to make space more affordable.

Professor Wertz is President of Microcosm Inc. that he established in 1984. The mission of the Hawthorn, California, based company is “to reduce cost and enable responsive, affordable and innovative space missions.” An accomplished space technologist and author, Wertz has taught a course “The Design of Low Cost Space Missions” in the USC Astronautics program since 1998.

*Space News* is one of the world’s leading publications on space.
This new 2-page flyer can be downloaded at [http://astronauticsnow.com/2014msaste2p.pdf](http://astronauticsnow.com/2014msaste2p.pdf)

Please forward it to your colleagues and friends who might be interested in applying to the USC program *Master of Science in Astronautical Engineering*. Thank you!

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**Article about USC MS ASTE**


The article is in an open access category, so it can be freely stored, copied, and distributed. It can be downloaded from [http://dx.doi.org/10.1016/j.actaastro.2014.06.016](http://dx.doi.org/10.1016/j.actaastro.2014.06.016) or [http://astronauticsnow.com/2014aste.pdf](http://astronauticsnow.com/2014aste.pdf)

Please feel free to forward it to your colleagues and friends who might be interested.
Some ASTE students aspire to become astronauts.

On November 5, 2015, NASA released the following announcement:

In anticipation of returning human spaceflight launches to American soil, and in preparation for the agency’s journey to Mars, NASA announced it will soon begin accepting applications for the next class of astronaut candidates. With more human spacecraft in development in the United States today than at any other time in history, future astronauts will launch once again from the Space Coast of Florida on American-made commercial spacecraft, and carry out deep-space exploration missions that will advance a future human mission to Mars.

The agency will accept applications from Dec. 14 through mid-February and expects to announce candidates selected in mid-2017.

More details of the announcement at

Information about astronaut application requirements at http://astronauts.nasa.gov/ (figure below).
The Space Show has been on air for almost 15 years and it is heard in more than 50 countries around the world.

http://thespaceshow.com

The host and ASTE program supporter, Dr. David Livingston (right), usually broadcasts a few times each week. In contrast to many other talk shows, the discussions with guests last 1.5 hours or longer which allows 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 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 other traditional areas of the space enterprise. Many leading specialists including former NASA administrators, top scientists and technologists, space entrepreneurs, writers, and leaders of space advocacy groups were among its guests. The list also includes at least six ASTE instructors.

All shows – more than 2500 – are archived and conveniently accessible through the web site http://thespaceshow.com. One can search for various topics and guests, download the mp3 files (usually 40-50MB), and listen on computers or other devices. Many listen programs live on the Internet and call with the questions.

The Space Show is a great resource for Astronautics students.
Schedule of Astronautics Courses

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

While we carefully plan our course offerings, it is the Dean’s Office that makes the final decision on course offering. Then, there is a challenge of availability of DEN studios. You may call it, using the language of physics and mathematics, the “boundary conditions” or “constraints.” In addition, sometime our instructors from industry and government centers cannot offer scheduled courses due to work-related emergencies. We try to minimize such occurrences, but they are outside our direct control.

Some schedule changes and new courses in the spring, summer, and fall semesters of 2016 and the required courses in academic year 2016-2017

Spring 2016  –  ASTE-572 and two new courses (ASTE-599’s)

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<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Instructor</th>
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<tbody>
<tr>
<td>ASTE 599</td>
<td>Space Cryogenic Systems and Applications (p. 15)</td>
<td>Dr. Sidney Yuan (The Aerospace Corporation)</td>
</tr>
<tr>
<td>ASTE 599</td>
<td>Reliability of Space Systems (p. 16)</td>
<td>Dr. Leila Meshkat (RAND Corporation)</td>
</tr>
<tr>
<td>ASTE 572</td>
<td>Advanced Spacecraft Propulsion</td>
<td>Dr. Keith Goodfellow (Aerojet Rocketdyne)</td>
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</table>

On-campus students enroll in the DEN section (please contact ASTE Student Advisor if you have questions)

Summer 2016

ASTE 585 Spacecraft Attitude Control (Prof. Henryk Flashner, USC) is scheduled for the summer semester 2016.

Fall 2016

ASTE 527 Space Architecting Studio – enrollment limited to 10 students

Madhu Thangavelu (AAA Vis.)

Academic year 2016–2017  –  required courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Availability</th>
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<tbody>
<tr>
<td>ASTE 520</td>
<td>Spacecraft Systems Design</td>
<td>Fall (2016) semester only</td>
</tr>
<tr>
<td>ASTE 535</td>
<td>Space Environment and Spacecraft Interactions</td>
<td>Fall (2016) and Spring (2017) semesters</td>
</tr>
<tr>
<td>ASTE 580</td>
<td>Orbital Mechanics I</td>
<td>Fall (2016) and Spring (2017) semesters</td>
</tr>
<tr>
<td>ASTE 470</td>
<td>Spacecraft Propulsion</td>
<td>Fall (2016) semester only</td>
</tr>
</tbody>
</table>
Spring 2016

This course introduces students to a broad view of various sensor cooling techniques used in the space industry, ranging from the conventional radiative cooling to the use of superfluid as cryogen and superconductor to detect x-rays. Students will be introduced to the special theory of superfluidity with zero viscosity to flow, and that of superconductivity without electrical resistance. Various techniques like cryoradiators, cryogen cryostats and mechanical cryocoolers will be discussed.

Topics

Cooling of Infrared Sensors / Optics
- by cryostats (including superfluid dewars)
- by cryoradiators
- by cryocoolers (mechanical)

Detection of X-Rays
- by superconductor technology

Cryogenic Components
- flexible Links
- thermal switches
- heat transport units (e.g., heat pipes)
- thermal storage units

Cryogenic Properties and Safety

Textbook

Course notes

Instructor:
Dr. Sidney W.K. Yuan (The Aerospace Corporation)  sidneywyuan@gmail.com
**ASTE 599 Reliability of Space Systems**

**Spring 2016**

**Course Description**

This course provides engineering and science students with the tools and techniques necessary for reliable system design and operations. The students will be encouraged to think of the concepts of reliability and risk as measures of performance of a system and within the context of the system design, development and operational lifecycle.

The course will cover 1) the basic concepts and analytical methods of Systems Reliability Theory 2) Probabilistic Risk Assessment and its application to space systems and payloads and 3) The failure behaviors of modern flight computer based systems. The course textbook will be supplemented with papers that describe the application of risk and reliability engineering to space systems.

The course project (individual) will provide students with an opportunity to study and formulate an example reliability and risk assessment problem of their choice and each student will be required to prepare an initial problem formulation/proposal for their project after the midterm and then a short final report.

**Topics:**

- Introduction to Reliability & Risk Engineering
- Review of Probability
- Failure Models
- Fault Tree Analysis
- Markov Models
- Component Importance and Sensitivity Analysis
- Probabilistic Risk Assessment
- Reliability Engineering for Computer Based Systems
- Bayesian Belief Networks
- Review of Statistics
- Data Analysis for Reliability Engineering

**Textbooks and other materials:**


**NASA Probabilistic Risk Assessment Guideline** – to be available online.

**Instructor:** Dr. Leila Meshkat (RAND), meshkat@usc.edu
Astronautics Classes offered in the Spring semester, 2016

Core Requirements

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<tr>
<th>Course</th>
<th>Title</th>
<th>Instructor</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTE 580 (3)</td>
<td>Orbital Mechanics I</td>
<td>Prof. Gerald Hintz</td>
<td>DEN-webcast</td>
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<tr>
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<td>(Aerospace Corp.)</td>
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Core Elective and Elective Requirements

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<tr>
<th>Course</th>
<th>Title</th>
<th>Instructor</th>
<th>Location</th>
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<tbody>
<tr>
<td>ASTE 524 (3)</td>
<td>Human Spaceflight</td>
<td>Prof. Bruce Cordell</td>
<td>DEN-webcast</td>
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<tr>
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<td>(21st Century Waves)</td>
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<tr>
<td>ASTE 552 (3)</td>
<td>Spacecraft Thermal Control</td>
<td>Dr. G. P. Purohit</td>
<td>DEN-webcast</td>
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<td></td>
<td></td>
<td>(Aerospace Corp.)</td>
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</tr>
<tr>
<td>ASTE 572 (3)</td>
<td>Advanced Spacecraft Propulsion</td>
<td>Dr. Keith Goodfellow</td>
<td>DEN-webcast only</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Aerojet Rocketdyne)</td>
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<tr>
<td>ASTE 586 (3)</td>
<td>Spacecraft Attitude Dynamics</td>
<td>Dr. Troy Goodson</td>
<td>DEN-webcast</td>
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For more information on Master of Science degree program in Astronautical Engineering (MS ASTE) check [http://gapp.usc.edu/graduate-programs/masters/astronautical-engineering](http://gapp.usc.edu/graduate-programs/masters/astronautical-engineering) and contact ASTE Student Advisor Ms. Norma Perry (tel. 213–821–4234; norduna@usc.edu).

Instructors of *Astronautics* courses in Spring 2016 (alphabetically)

**Prof. Bruce Cordell**  
(21st Century Waves)  
ASTE 524  
*Human Spaceflight Systems*

**Dr. Leila Meshkat**  
(RAND Corp.)  
ASTE 599  
*Reliability of Space Systems*

**Dr. Keith Goodfellow**  
(Aerojet Rocketdyne Corp.)  
ASTE 572  
*Advanced Spacecraft Propulsion*

**Dr. G. P. Purohit**  
(The Aerospace Corp.)  
ASTE 570  
*Liquid Rocket Propulsion*

**Dr. Troy Goodson**  
(Jet Propulsion Laboratory)  
ASTE 586  
*Spacecraft Attitude Dynamics*

**Dr. Sidney Yuan**  
(The Aerospace Corporation)  
ASTE 599  
*Space Cryogenic Systems and Applications*

**Prof. Gerald Hintz**  
(The Aerospace Corporation)  
ASTE 580  
*Orbital Mechanics I*
Core Elective and Elective Requirements

<table>
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<th>Course</th>
<th>Title</th>
<th>Instructor</th>
<th>Type</th>
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<tbody>
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<td>ASTE 585 (3)</td>
<td>Spacecraft Attitude Control</td>
<td>Prof. Henryk Flashner (USC)</td>
<td>DEN-webcast</td>
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Astronautics Classes offered in the Fall semester, 2016

Core Requirements

**ASTE 470 (3)** – Spacecraft Propulsion  
Instructor: **Prof. Mike Gruntman** (USC)  
DEN-webcast

**ASTE 520 (3)** – Spacecraft System Design  
Instructor: **Prof. Mike Gruntman** (USC)  
DEN-webcast

**ASTE 535 (3)** – Space Environment and SC Interactions  
Instructor: **Dr. Kent W. Tobiska** (Space Environment Techn.)  
DEN-webcast

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

Core Elective and Elective Requirements

**ASTE 505a (3)** – Plasma Dynamics  
Instructor: **Prof. Joseph Wang** (USC)  
on-campus only

**ASTE 527 (3)** – Space Exploration Architectures Concept Studio  
Instructor: **Madhu Thangavelu** (AAA Visioneering)  
limited enrollment (5 on-campus and 5 DEN students)  
DEN-webcast

**ASTE 553 (3)** – Systems for Remote Sensing from Space  
Instructor: **Steven Matousek** (JPL)  
DEN-webcast

**ASTE 556 (3)** – Spacecraft Structural Dynamics  
Instructor: **Dr. Oscar Alvarez-Salazar** (JPL)  
DEN-webcast

**ASTE 599 (3)** – Solar System Navigation  
Instructor: **Prof. Gerald Hintz** (Aerospace Corp.)  
DEN-webcast

For more information on *Master of Science* degree program in *Astronautical Engineering* (MS ASTE) check [http://gapp.usc.edu/graduate-programs/masters/astronautical-engineering](http://gapp.usc.edu/graduate-programs/masters/astronautical-engineering) and contact ASTE Student Advisor Ms. Norma Perry (tel. 213–821–4234; norduna@usc.edu).

# Instructors of Astronautics courses in Fall 2016 (alphabetically)

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Course Number</th>
<th>Course Title</th>
<th>Institution</th>
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<tbody>
<tr>
<td>Dr. Oscar Alvarez-Salazar (JPL)</td>
<td>ASTE 556</td>
<td>Spacecraft Structural Dynamics</td>
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<tr>
<td>Prof. Mike Gruntman (Univ. of Southern California)</td>
<td>ASTE 470</td>
<td>Spacecraft Propulsion</td>
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<tr>
<td>Prof. Mike Gruntman (Univ. of Southern California)</td>
<td>ASTE 520</td>
<td>Spacecraft Systems Design</td>
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</tr>
<tr>
<td>Prof. Gerald Hintz (The Aerospace Corp.)</td>
<td>ASTE 599</td>
<td>Solar System Navigation</td>
<td></td>
</tr>
<tr>
<td>Steven Matousek (JPL)</td>
<td>ASTE 553</td>
<td>Systems for Remote Sensing from Space</td>
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<tr>
<td>Prof. Ryan Park (JPL)</td>
<td>ASTE 580</td>
<td>Orbital Mechanics I</td>
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<tr>
<td>Madhu Thangavely (AAA Visioneering)</td>
<td>ASTE 527</td>
<td>Space Studio Architecting</td>
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<tr>
<td>Prof. Kent Tobiska (Space Environment Technologies)</td>
<td>ASTE 535</td>
<td>Space Environments and Spacecraft Interactions</td>
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<tr>
<td>Prof. Joseph Wang (Univ. of Southern California)</td>
<td>ASTE 505a</td>
<td>Plasma Dynamics</td>
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## Preliminary Class Schedule (as of Nov. 2015)

### Astronautics (ASTE) Graduate Class Schedule

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

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<td>ASTE 520 Spacecraft Design</td>
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<td>ASTE 535 Space Environment and Spacecraft Interactions</td>
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### Elective Courses

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<td>ASTE 599 Descent, Entry, and Landing</td>
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</tbody>
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### Course Codes

- **SC** = spacecraft
- **R** = required MS ASTE
- **2** = course offered twice each year
- **C** = core elective MS ASTE
- **1** = course offered each year
- **E** = technical elective
- **#** = course offered every second year
- **D** = webcast through DEN
- **Ir** = course offered irregularly
- **N** = on campus; not available through DEN
- **▼** = planned (subject to Dean approval)
- **?** = uncertain, check with ASTE Student Advisor

*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

<table>
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<tr>
<th>CORE REQUIREMENT (12 units)</th>
<th>Units</th>
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<tr>
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<td>ASTE 520</td>
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<td>ASTE 535</td>
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<td>ASTE 580</td>
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<table>
<thead>
<tr>
<th>CORE ELECTIVE REQUIREMENT (9 units – choose three courses)</th>
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<tbody>
<tr>
<td>ASTE 501ab</td>
<td>3-3</td>
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<tr>
<td>ASTE 523</td>
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<td>ASTE 527</td>
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<td>ASTE 529</td>
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<td>ASTE 586</td>
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</table>

<table>
<thead>
<tr>
<th>TECHNICAL ELECTIVE REQUIREMENT (6 Units)</th>
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</table>

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 faculty advisor. 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 570  Liquid Rocket Propulsion  3
- ASTE 572  Advanced Spacecraft Propulsion  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

**Space system design**  Choose two core electives from
- ASTE 523  Design of Low Cost Space Missions  3
- ASTE 527  Space Studio Architecting  3
- ASTE 529  Safety of Space Systems and Space Missions  3
- ASTE 557  Spacecraft Structural Strength and Materials  3

**Spacecraft systems**  Choose two core electives from
- ASTE 552  Spacecraft Thermal Control  3
- ASTE 553  Systems for Remote Sensing from Space  3
- ASTE 554  Spacecraft Sensors  3
- ASTE 584  Spacecraft Power Systems  3

**Space applications**  Choose two core electives from
- ASTE 527  Space Studio Architecting  3
- ASTE 553  Systems for Remote Sensing from Space  3
- ASTE 554  Spacecraft Sensors  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 perspective 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 applicant's record which includes GPA, GRE, and two letters of recommendation.

**Required items:**

<table>
<thead>
<tr>
<th>Application</th>
<th>Office of Grad. and Int'l Admission</th>
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<tbody>
<tr>
<td>Official Transcript(s)</td>
<td>Office of Grad. and Int'l Admission</td>
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<tr>
<td>General Record Exam</td>
<td>Office of Grad. and Int'l Admission</td>
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<tr>
<td>TOEFL (international students only)</td>
<td>Office of Grad. and Int'l Admission</td>
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<tr>
<td>Financial Statement</td>
<td>Office of Grad. and Int'l Admission</td>
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<tr>
<td>Recommendation Letters</td>
<td>Office of Grad. and Int'l Admission</td>
</tr>
</tbody>
</table>

**Application**

All applications should be submitted on-line at [http://www.usc.edu/admission/graduate/apply/](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 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](https://www.usc.edu/admission/graduate/international/englishproficiency.html).
Recommendation Letters

Please provide two professional letters of reference (former instructors, supervisors, professional colleagues, advisors, etc.) to be filed through the on-line 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, 854 W. Downey Way
University of Southern California
Los Angeles, CA 90089-1192

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 3.00 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 a number of limited-status students in the program.

Admission

Applicants will be notified once a decision has been reached by ASTE Search Committee. 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 student 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 (RRB–225; tel. 213–821–5817; cuason@usc.edu) and Student Advisor Ms. Norma Perry (RRB–223; tel. 213–821–4234; norduna@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 VSOE change of major form and contact ASTE Student Advisor Ms. Norma Perry (RRB–223; tel. 213–821–4234; norduna@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 Advisor Ms. Norma Perry (RRB–223; tel. 213–821–4234; norduna@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 (RRB–225; 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 work load 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 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 (RRB–225; tel. 213–821–5817; cuason@usc.edu) and visit http://astronautics.usc.edu.