University of Southern California
Viterbi School of Engineering
Astronautics and Space Technology

B.Sc., Minor, M.Sc., Engineer, and Ph.D. Degrees and Graduate Certificate in Astronautical Engineering

The center of space technology is Los Angeles.

In the heart of Los Angeles,
the leader in space education is USC.

Space Science and Exploration

National Security Programs

Commercial Space

Realize your dream of studying and working in astronautics and space technology with USC’s degree programs in Astronautics and Space Technology

Check for updates at http://astronautics.usc.edu/brochure
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Astronautics and Space Technology Division Chairman:
Prof. Mike Gruntman

Program Coordinators

Bachelor of Science:  Prof. Dan Erwin
Master of Science:   Prof. Mike Gruntman
Engineer:    Prof. Joseph Kunc
Doctor of Philosophy:  Prof. Joseph Kunc
Certificate:     Prof. Mike Gruntman

Program Faculty and Lecturers

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<td>Prof. Elliot Axelband (USC&amp;Hughes, ret.)</td>
<td>Systems Architecting</td>
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<td>Prof. Robert F. Brodsky (USC&amp;TRW, ret.)</td>
<td>Spacecraft and Space Mission Design</td>
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<td>Dr. Alok Chatterjee (JPL)</td>
<td>Spacecraft Design</td>
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<td>Prof. H.K. Cheng (USC)</td>
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<td>Prof. Dan Erwin (USC)</td>
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<td>Dr. Anthony Freeman (JPL)</td>
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<td>Communication Signal Design</td>
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<td>Dr. Keith Goodfellow (Lockheed-Martin)</td>
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<td>Prof. Mike Gruntman (USC)</td>
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<td>Prof. Yan Jin (USC)</td>
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<td>Prof. Darrell L. Judge (USC)</td>
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<td>Dr. Andrew Ketsdever (AFRL)</td>
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<td>Prof. Bart Kosko (USC)</td>
<td>Signal Processing and Neural-Fuzzy Systems</td>
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<td>Dr. Michael Kezirian (Boeing)</td>
<td>Spacecraft Dynamics</td>
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<tr>
<td>Prof. Joseph A. Kunc (USC)</td>
<td>Plasmas/Gas Kinetics; Molec.&amp;Rad. Processes</td>
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<td>Dr. Johnny Kwok (JPL)</td>
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<td>Prof. John McIntyre (USC&amp;HSC, retired)</td>
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<td>Prof. E. Phil Muntz (USC)</td>
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<td>Dr. Robert Parker (Northrop-Grumman)</td>
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<td>Dr. Geraldine Peters (USC)</td>
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<td>Dr. G.P. Purohit (Boeing)</td>
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<td>Prof. Stan Settles (USC)</td>
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<td>Prof. Donald E. Shemansky (USC)</td>
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<td>Dr. Madhu Thangavelu (AAA Visioneering)</td>
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<td>Dr. Kent Tobiska (Space Envormn. Techn.)</td>
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<td>Prof. Firdaus E. Udwadia (USC)</td>
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<tr>
<td>Dr. James Wertz (Microcosm)</td>
<td>Space Mission Design</td>
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<td>Prof. Peter Will (USC-ISI)</td>
<td>Robotics and Space Assembly</td>
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<tr>
<td>Prof. Bingen Yang (USC)</td>
<td>Structural Dynamics</td>
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AFRL = Air Force Research Laboratory      HSC = Hughes Space and Communications
ISI = USC’s Information Sciences Institute JPL = Jet Propulsion Laboratory, NASA
Bachelor of Science in Astronautical Engineering

The USC Astronautics and Space Technology Division Offers the Degree of Bachelor of Science in Astronautical Engineering

Curriculum

Freshman Year, fall
ASTE 101L
Introduction to Astronautics
MASC 110L, Chem 105aL, or Chem 115aL
Chemical Properties of Materials, or General Chemistry, or Advanced General Chemistry
Math 125
Calculus I
General Education Elective

Freshman Year, spring
AME 150L
Intro to Computational Methods in AME
Math 126
Calculus II
Phys 151L
Physics I: Mechanics & Thermodynamics
Writ 140
Writing and Critical Reasoning

Sophomore Year, fall
AME 201
Statics
Math 226
Calculus III
Phys 152L
Physics II: Electricity and Magnetism
General Education Elective

Sophomore Year, spring
AME 204
Strength of Materials
Math 245
Mathematics of Physics and Engineering I
Phys 153L
Physics III: Optics and Modern Physics
ASTE 280
Astronautics and Space Environment I
General Education Elective

Junior Year, fall
AME 301
Dynamics
ASTE 301a
Thermal and Statistical Systems I
AME 404
Comp. Solutions to Engineering Problems
AME 341aL
Mechoptronics Laboratory I
ASTE 330
Astronautics and Space Environment II

Junior Year, spring
AME 308
Computer-Aided Analysis for Aero-Mechanical Design
ASTE 301b
Thermal and Statistical Systems II
AME 341bL
Mechoptronics Laboratory II
WRIT 340
Advanced Writing Course
General Education Elective

Senior Year, fall
AME 441aL
Senior Projects Laboratory
ASTE 470
Spacecraft Propulsion
3 Technical Electives

Senior Year, spring
ASTE 420
Spacecraft Design
ASTE 480
Spacecraft Dynamics
2 Technical Electives
General Education Elective

Check for updates at http://astronautics.usc.edu/brochure
Required Astronautics Courses

ASTE 101L
Introduction to Astronautics
Gateway to the Astronautics area of emphasis. Introduction to space, space exploration and the space business. Elements of orbits, spacecraft systems, rocket propulsion, and communications. Laboratory: Introduction to graphics, computation and simulation.

ASTE 280
Astronautics and Space Environment I

ASTE 301a,b
Thermal and Statistical Systems

ASTE 330
Astronautics and Space Environment II

ASTE 420
Spacecraft Design
Spacecraft mission design, space environment, attitude determination and control, telecommunications, propulsion, structures and mechanisms, thermal control, power systems, launch systems and facilities. Semester design project.

ASTE 470
Spacecraft Propulsion

ASTE 480
Spacecraft Dynamics

Microsatellite Project
The Microsatellite Project is a student group within the Astronautics and Space Technology Division (ASTD). Its purpose is to enable students to obtain hands-on experience with space hardware through designing, building, and launching small satellites and satellite components. The faculty advisor for the Project is Prof. Dan Erwin. Students participate in the project on a volunteer basis.

Recommended Technical Electives

ASTE 445
Molecular Gas Dynamics

ASTR 400
The Solar System

EE 464
Probability Theory for Engineers

AME 477
Solar System Exploration

Check for updates at http://astronautics.usc.edu/brochure
Master of Science in Astronautical Engineering

The USC Astronautics and Space Technology Division Offers the Degree of Master of Science in Astronautical Engineering

Required Course Work

Minimum number of units - 27
Core Requirement - 6 units
   ASTE 520 (3) Spacecraft System Design
   ASTE 535 (3) Space Environments and Spacecraft Interactions
Core Elective Requirement - 3 units
   Choose one 3-unit courses from the list of Astronautics core elective requirement classes (p.8)
Technical Elective Requirement - 12 units
   Four 3-unit courses. It is advisable to select these four elective courses from the list of Astronautics core electives or Astronautics recommended electives (p.8). Other science and engineering classes can also be taken to satisfy the technical elective requirement (program approval required).
   No more than three units of directed research (ASTE 590) can be applied to the 27-unit degree requirement.

Engineering Mathematics Requirement - 6 units
   AME 525(3) and AME 526(3) Engineering Analysis

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

- All School of Engineering general requirements for the Master of Science must be satisfied
- A student may choose to write a Master’s Thesis (credit 4 to 8 units)
- All core requirement, core elective (except one course), and engineering mathematics requirement courses are available through USC Distance Education Network DEN (p.19).

Check for updates at http://astronautics.usc.edu/brochure
M.S. in Astronautical Engineering
Core, Core Elective, and Elective Courses

Astronautics Core Courses (Required):
* ASTE 520 (3) — Spacecraft System Design
* ASTE 535 (3) — Space Environments and Spacecraft Interaction

Astronautics Core Elective Courses:
* ASTE 470 (3) — Spacecraft Propulsion
* ASTE 523 (3) — Design of Low Cost Space Missions
* ASTE 552 (3) — Spacecraft Thermal Control
* ASTE 553 (3) — Systems for Remote Sensing from Space
* ASTE 556 (3) — Spacecraft Structural Dynamics
* ASTE 580 (3) — Orbital Mechanics I
* ASTE 581 (3) — Orbital Mechanics II
* ASTE 583 (3) — Space Navigation: Principles and Practice
* ASTE 584 (3) — Spacecraft Power Systems
* ASTE 585 (3) — Spacecraft Attitude Control
* ASTE 586 (3) — Spacecraft Attitude Dynamics

Astronautics Recommended Technical Elective Courses:
ASTE 501a(3) — Physical Gas Dynamics I
ASTE 501b(3) — Physical Gas Dynamics II
ASTE 527 (3) — Space Studio Architecting
ASTE 541 (3) — Partially Ionized Plasmas
ASTE 545 (3) — Computational Techn. in Rarefied Gas Dynamics
* ASTE 572 (3) — Advanced Spacecraft Propulsion
* SAE 549 (3) — Systems Architecting I
AME 511 (3) — Compressible Gas Dynamics
* AME 513 (3) — Principles of Combustion
AME 521 (3) — Engineering Vibrations II

In the future, we plan to offer courses in Constellation Design, Manned Spaceflight, Space Communications, Advanced Chemical Propulsion, Space Science, Hypersonics, and other space technology topics. Introduction of these new classes depends on availability of qualified instructors, distance education webcasting slots, and other programmatic factors.

Astronautics Engineering Mathematics Courses (Required):
* AME 525(3) — Engineering Analysis
* AME 526(3) — Engineering Analytical Methods

* Courses marked with * are available (webcast) through the USC Distance Education Network (DEN). See p.19.

The Astronautics and Space Technology Division does not require that classes be taken in any particular sequence, except that a class may only be taken after its prerequisites have been satisfied; check class descriptions in the USC Catalogue. The class sequence is established by students with the help of program faculty, if needed.

Check for updates at http://astronautics.usc.edu/brochure
M. S. in Astronautical Engineering
Admission Requirements

1. **B.S. in Science or Engineering**
   In some cases the applicant may be required to take 1 or 2 deficiency courses (undergraduate classes, e.g., ASTE 470 Spacecraft Propulsion). The decision to require deficiency courses is made by the Astronautics Program coordinators.

   Good news: the required deficiency 400-level courses can be applied for credit, as technical electives, toward the M.S. degree. Note that no more than two 400-level courses can be applied toward the M.S. degree.

2. **Grade Point Average (GPA)**
   – at least 3.0 (A ≡ 4.0)

3. **GRE**
   The general portion of the Graduate Record Examination (GRE) is required

4. **Recommendation Letters**
   Two recommendation letters, characterizing academic, professional, and personal qualities of the applicant, are required. Strong letters are particularly important for conditional admission.

   In some cases, a student may be admitted to the program conditionally. A condition might be to maintain “grades of B or better in each course” or “average grade B or better” before the completion of 12 units of course work. The decision to admit a student conditionally is made by the Astronautics Program coordinators.

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**Limited status and non-degree option students**

Please note that the School of Engineering allows enrollment as a limited status student (Astronautics and Space Technology Division permission is required) and as a non-degree option (NDO) student (Distance Education students only), without being formally accepted to a specific degree program. Not more than 12 units may be taken as a limited status student; only the first 12 units taken as an NDO student may be later applied for credit toward an advanced degree. This path is usually a convenient way to begin taking classes while the admission application is processed.
# Astronautics Graduate Class Schedule

(subject to change – check with the Program Student Coordinator)

<table>
<thead>
<tr>
<th>Core Requirement Courses</th>
<th>2005</th>
<th>2006</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2008</th>
<th>2009</th>
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<tbody>
<tr>
<td>ASTE 520 Spacecraft Design</td>
<td>Fall</td>
<td>Spring</td>
<td>Fall</td>
<td>Spring</td>
<td>Fall</td>
<td>Spring</td>
<td>Fall</td>
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<tr>
<td>ASTE 535 Space Environment and Spacecraft Interactions</td>
<td>1</td>
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<tbody>
<tr>
<td>ASTE 470 Spacecraft Propulsion</td>
<td>Fall</td>
<td>Spring</td>
<td>Fall</td>
<td>Spring</td>
<td>Fall</td>
<td>Spring</td>
<td>Fall</td>
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<td>ASTE 501a Physical Gas Dynamics I</td>
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<td>ASTE 501b Physical Gas Dynamics II</td>
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<td>ASTE 523 Design of Low Cost Space Missions</td>
<td>2</td>
<td>D</td>
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<td>ASTE 527 Space Studio Architecting</td>
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<td>ASTE 545 Comput. Techniques in Rarefied Gas Dynamics</td>
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<td>ASTE 572 Advanced SC Propulsion</td>
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<td>AME 511 Compress. Gas Dynamics</td>
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<td>AME 513 Principles of Combustion</td>
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<tr>
<td>AME 525 Engineering Analysis</td>
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Legend:  
- SC = spacecraft  
- R = required  
- 1 = class offered each year  
- C = core elective  
- 2 = class offered every second year  
- E = technical elective  
- Ir = class offered irregularly  
- D = webcast through DEN  
- N = not available through DEN  
(check with the student coordinator)

Core requirement and mathematics requirement courses are offered each year.  
Many technical electives are offered every second year or irregularly.  
We plan to offer new (additional) classes on space technology.  
Check with the program student coordinator when planning the class sequence.
Astronautics Graduate Classes: Syllabi

Core Requirements

ASTE 520
Spacecraft System Design

1. History of space exploration.
4. Orbit design: basic orbits, perturbations, ΔV.
5. Space mission geometry; astrodynamics.
7. Guidance, navigation and control; attitude determination; reaction control system. GPS.
8. Spacecraft propulsion.
9. Launch systems.
10. Communications.
11. TT & C; data handling.
12. Electric power systems.
13. Thermal control.

ASTE 535
Space Environments and Spacecraft Interactions

1. Kinetic theory, atomic and molecular physics.
5. Neutral environment - atomic oxygen.
7. Radiation environment - high-energy particles and photons.
8. Outgassing, satellite drag, contamination.
9. Spacecraft ("Shuttle") glow, material degradation.
10. Spacecraft charging, discharging.
11. Sputtering, single event effects.
12. Ground based simulations of the space environment.

Mathematics Requirements

AME 525
Engineering Analysis

5. Residue theory. 2-D inviscid fluid flow and conformal mapping.

AME 526
Engineering Analytical Methods

2. Second order linear theory. Introduction to heat, wave, Laplace equations. Diffusion equation; 1-D wave equation.
3. First order theory; characteristics. Quasi-linear equations; shocks.

Check for updates at http://astronautics.usc.edu/brochure
Core Technical Electives and Recommended Technical Electives

ASTE 470
Spacecraft Propulsion

7. Rocket heat transfer.

ASTE 501a
Physical Gas Dynamics I

1. Modern description of gas properties: microscopic vs. macroscopic approach; probability and statistical mathematics; phase spaces; classical vs. quantum approach.
2. Quantum mechanics: wave functions, structure of particles, translational, rotational, vibrational and electronic properties of molecules.
4. Molecular thermodynamics: molecular equation of state, entropy, internal energy, enthalpy, specific heats, Gibbs energy.
5. Forces between particles: multipoles; chemical bond; intermolecular potentials.

ASTE 501b
Physical Gas Dynamics II

1. Interaction of particles: elastic and inelastic collisions; cross sections and rate coefficients.
2. Gas kinetics: fluxes of particles and energy; the law of mass action; ionization and dissociation of gas; recombination of particles.
3. Plasmas: partially and fully ionized gas; Saha equation; interaction of waves with particles.
4. Transport properties: Boltzmann equation; conductivity, viscosity and diffusion coefficient, relaxation processes.
5. Radiative processes: blackbody radiation, radiative transfer equation, emission and absorption of radiation; distribution of photon energies; statistics of photons.

ASTE 523
Design of Low Cost Space Missions

1. Background – range of cost options, traditional vs. radical cost cutting methods.
2. Process changes to reduce cost - concurrent engineering, design-to-cost, schedule compression.
3. Technology for reduced cost – hardware, software, autonomy.
5. Case studies – missions with successfully reduced cost.
7. Design study.
ASTE 527
Space Studio Architecting

1. Architecting and programatics for complex space missions.
2. The "wicked problem," "out of bounds" parameters.
4. Global, top level space exploration and development architectures.
5. Alternative concepts creation: iterative design evolution.
6. Individual and team project.
7. Case study lectures by experts.
8. Faculty/NASA/Industry review and evaluation panel.

ASTE 545
Computational Techniques in Rarefied Gas Dynamics

5. Complete 1D DSMC. Shock structure.
6. 2D and axisymmetric grids. Indexing schemes. Weighting factors.
7. Inelastic collisions: rotation and vibration.

ASTE 541
Partially Ionized Plasmas

1. Laboratory and space plasmas.
2. Non-equilibrium, steady-state, and local thermodynamic equilibrium.
3. Forces between particles.
5. Distributions of charged particles.
6. Transport properties in plasmas.
7. Plasmas in electric and magnetic fields.

ASTE 552
Spacecraft Thermal Control

1. Requirements, basic principles, and applications of spacecraft thermal management and control.
2. Spacecraft thermal environments.
3. Thermal verification requirements.
4. Test facilities, and practices.
5. Basic heat transfer modes.
6. Insulation, radiators, fluid thermal control systems and heat pipes.

ASTE 553
Systems for Remote Sensing

4. Thermal infrared remote sensing.
5. Passive microwave remote sensing.
6. Real and synthetic aperture radars.
7. Altimeters and scatterometers.
8. Polarimetric and interferometric synthetic aperture radar.
10. Visible and near infrared remote sensing: atmospheres
11. Millimeter and submillimeter sensing of atmospheres.
12. Microwave remote sensing: atmospheres.
ASTE 556
Spacecraft Structural Dynamics
1. Introduction: Structural Dynamics, Spacecraft Design, & Analytical Tools
2. Vibration of Single and Multiple Degree of Freedom Systems
3. Infinite Degree of Freedom Systems
5. Structural Dynamics Modeling of Spacecraft
6. Analysis of spacecraft dynamics
7. Computation of Spacecraft Dynamic Loads
8. Dynamics Testing of Spacecraft

ASTE 572
Advanced Spacecraft Propulsion
1. Review of rocket fundamentals.
2. Basics of advanced propulsion.
3. Nuclear rockets.
4. Space power systems (nuclear and solar).
5. Fundamentals of electric propulsion: electromagnetics, ionization of gases, particle collisions, electrode effects.
6. Acceleration mechanisms: electro-thermal, electrostatic, electromagnetic.
7. Electric propulsion thrusters.
8. Electric propulsion systems: power, propellant, and control.
10. Special applications: tethers, micro-propulsion, piloted Mars mission.

ASTE 580
Orbital Mechanics I
1. Physical principles.
2. Coordinate systems and transformations.
3. Two-body and central force motion.
4. Hill’s equation; position and velocity formulas.
5. Lambert’s problem and mission design.
7. Potential function for a distributed mass.
9. Maneuver design techniques.
10. Rocket equation; satellite orbit paradox.

ASTE 581
Orbital Mechanics II
1. Non-spherical central body.
2. Luni-solar gravitational forces.
3. Drag and propulsion.
4. High-precision mathematical methods.
5. Station-keeping of geosynchronous satellites.
7. Gravity assist maneuvers.
8. Launch window design.

ASTE 583
Space Navigation: Principles and Practice
1. Navigating the solar system: an overview.
2. Required mathematical background; an overview of probability and statistics.
3. The orbit determination problem.
4. Error sources included in statistical analyses.
5. The (weighted) least squares solution; minimum variance and maximum likelihood solutions.
6. Computational algorithms for batch and sequential processing; state noise compensation; smoothing.
7. Square-root filter algorithms.
8. Elementary illustrative examples.

Check for updates at http://astronautics.usc.edu/brochure
9. Consider covariance analyses.
11. Launch considerations; rocket payloads and staging; launch vehicles and sites.
12. Space navigation principles and practice – trajectory optimization, orbit estimation (radiometric and optical navigation), and flight path control.

ASTE 584
Spacecraft Power Systems

1. Requirements and environment.
5. Power electronics.
7. Power system design topologies.
8. Emerging technologies.

ASTE 585
Attitude Control of Spacecraft

1. Spacecraft dynamics and kinematics: Euler moment equations; rotational motion of a spinning body; dissipation effects; spacecraft attitude dynamics; actuators and sensors.
2. Review of control theory: transfer functions; frequency response; stability; state space representation.
3. Gravity-gradient stabilization: basic attitude control equation; gravity gradient attitude control with passive and active damping.
4. Magnetic attitude control.
5. Attitude maneuvers.
7. Reaction thruster attitude control.

ASTE 586
Spacecraft Attitude Dynamics

1. Mathematical preliminaries.
2. Kinematics and dynamics.
4. Spinning spacecraft.
5. Lagrangian and Hamiltonian mechanics
6. Dual spin spacecraft.
7. Environmental and disturbance torques.
8. Gravity gradient spacecraft.
9. Momentum bias spacecraft.

SAE 549
Systems Architecting I

1. System concepts.
2. The system architecting process.
3. Requirements generation.
4. Boundaries and interfaces.
5. Modeling, simulation, and prototyping.
6. Architecting tools.
7. Building systems.
8. System test, acceptance, and operations.

AME 511
Compressible Gas Dynamics

1. Compressible flow equations.
2. One-dimensional and quasi-one-dimensional flows.
3. Shocks and expansion waves.
4. Unsteady wave motion.
5. Linearized flow.
7. Three-dimensional flow.
8. Transonic flow.
9. Hypersonic flow.
AME 513
Principles of Combustion

1. Thermodynamics of pure substances and mixtures.
2. Chemical kinetics & combustion chemistry.
3. Transport phenomena: simplified and rigorous derivation of transport coefficients.
5. Theory of non-premixed flames.
7. Aerodynamics of laminar flames.
9. Introduction to numerical simulations of multi-component reacting flows.

Check for updates at http://astronautics.usc.edu/brochure 16/20
Engineer Degree in Astronautical Engineering

The USC Astronautics and Space Technology Division Offers the Engineer Degree in Astronautical Engineering

Admission Requirements:
1. General admission requirements for the Engineer Degree of the School of Engineering
2. Admission requirements for the M.S. Degree in Astronautical Engineering (see p.9)

Check for the details with the Engineer Degree Program Coordinator

Doctor of Philosophy in Astronautical Engineering

The USC Astronautics and Space Technology Division Offers the Ph.D. Degree in Astronautical Engineering

Admission Requirements:
1. General requirements for the Ph.D. Degree of the School of Engineering
2. B.S. or M.S. in science or engineering
   If some cases one or more undergraduate courses may be required to prepare for the graduate coursework.
3. Grade Point Average (GPA) – at least 3.5 (A=4.0)
4. GRE
   The general portion of the Graduate Record Examination (GRE) is required
5. Recommendation Letters
   Three recommendation letters, characterizing academic, professional, and personal qualities of the applicant, are required.

Check for details with the Ph.D. Degree Program Coordinator

Check for updates at http://astronautics.usc.edu/brochure
Certificate in Aerospace Engineering (Astronautics)

The USC Astronautics and Space Technology Division Offers the Certificate in Aerospace Engineering (Astronautics)

The Program is designed for practicing engineers and scientists who enter space-related fields and/or who want to obtain training in specific space-related areas. The students can enroll at USC as limited status students and have to apply and be admitted to the certificate Program not later than completion of 9 units of the required coursework. A special Certificate is issued after completion of the coursework.

Required Course Work – 12 units (choose four 3-unit courses):

* ASTE 520 (3) – Spacecraft System Design
* ASTE 535 (3) – Space Environments and Spacecraft Interaction
* ASTE 523 (3) – Design of Low Cost Space Missions
* ASTE 552 (3) – Spacecraft Thermal Control
* ASTE 553 (3) – Systems for Remote Sensing from Space
* ASTE 556 (3) – Spacecraft Structural Dynamics
* ASTE 580 (3) – Orbital Mechanics I
* ASTE 581 (3) – Orbital Mechanics II
* ASTE 583 (3) – Space Navigation: Principles and Practice
* ASTE 584 (3) – Spacecraft Power Systems
* ASTE 585 (3) – Spacecraft Attitude Control
* ASTE 586 (3) – Spacecraft Attitude Dynamics
* ASTE 572 (3) – Advanced Spacecraft Propulsion

For class schedule, please consult p. 11.

Admission Requirements:
1. B.S. in Engineering or Science
2. GPA - 3.00

Distance Education Network
* Courses marked with * are available (televised and webcast) through the USC Distance Education Network (DEN). See p.19.

Credit
Credit for classes may be applied toward the M.S. or Ph.D. in Astronautical Engineering should the student decide later to pursue an advanced degree. In order to be admitted to the M.S. Program the student should maintain a B average or higher in courses for the Certificate and must satisfy all normal admission requirements. All courses for the Certificate must be taken at USC.

Check for updates at http://astronautics.usc.edu/brochure
Astronautics and Space Technology

Distance Education

**USC Distance Education Network (DEN)**

Established in 1972, the USC Distance Education Network (DEN) is an extensive, interactive one-way video, two-way audio e-learning system that enables full-time professional engineers to take USC School of Engineering courses for graduate degree credit from the convenience of their company facilities or homes.

Regular campus classes are webcast (Internet-accessible), making them available to students for USC graduate credit and auditing, practically anywhere in the United States. The DEN web site – [http://den.usc.edu](http://den.usc.edu) - provides extensive program and contact information.

**Astronautics Program via Distance Learning**

Employees of companies affiliated with USC DEN can obtain the degrees of *Master of Science in Astronautical Engineering* and *Certificate in Aerospace Engineering (Astronautics)* from remote locations. In addition, DEN can accommodate the independent student; this latter category is rapidly growing. All required and core elective classes and many elective classes are webcast. Thus, Astronautics students taking classes via DEN have an excellent choice of space technology courses.

**DEN Company Affiliates** (the list is growing – check with DEN for update)

- Aerojet
- Aerospace Corp.
- The Boeing Company
- The CATE Center
- Department of Water and Power
- Ericsson Wireless Communications, Inc.
- General Dynamics
- Intel Corporation
- ITT/Gilfillan
- Lockheed Martin
- Motorola
- NASA — Ames Research Center
- NASA — Dryden Flight Research Center
- NASA — Jet Propulsion Laboratory
- NASA — Johnson Space Center
- NASA — Kennedy Space Center
- Northrop Grumman
- Odetics
- OralScan Laboratories Inc.
- Orange County Regional Classroom
- Qualcomm Inc.
- Raytheon
- SAIC
- Spectrum Astro, Inc.
- United Technologies (UTC)
- Volt Delta Resources
- Xerox Corp.

**Independent students**

Students may enroll in DEN programs on their own, rather than through a DEN affiliate. Such independent students may reside anywhere in the United States.

Check for updates at [http://astronautics.usc.edu/brochure](http://astronautics.usc.edu/brochure)
University of Southern California

Astronautics and Space Technology

B.Sc., M.Sc., Engineer, and Ph.D. Degrees and Certificate

Application

You have decided to apply to a program offered by the Astronautics and Space Technology Division. What’s next?

1. Read this brochure

2. Look at the Program web site at http://astronautics.usc.edu for the program updates and frequently asked questions.

3. An application is available on-line at http://www.usc.edu/dept/admissions/grad.

4. Contact the Astronautics Program Student Coordinator
   telephone: 213-821-5817
   e-mail: astd@usc.edu
   for additional information. The Astronautics Program Student Coordinator is your contact regarding all questions related to the application procedure, paperwork, etc.

4. If needed, contact the appropriate Astronautics Program Faculty Coordinator (see p.3) with questions regarding class selection, program focus, etc.
   e-mail: info@astronautics.usc.edu

Good Luck!

Per Aspera Ad Astra!