

# AEROSPACE ENGINEERING, M.S.

The Graduate School has general requirements for M.S students that must be met by all degree candidates (including earning at least 30 credit hours beyond the bachelor's degree for master's degrees). The Aerospace Engineering Program has added requirements (which are listed below) that must be met before students can complete their degrees.

## Learning Outcomes

- Students will demonstrate a sound understanding of the characteristics of low speed aerodynamics, transonic aerodynamics and supersonic aerodynamics.
- Students will demonstrate a sound understanding of the modelling of incompressible inviscid, viscous and compressible flow.
- Students will demonstrate a sound understanding of applied aircraft aerodynamics, airfoil and wing theory and of aerodynamic design.
- Students will demonstrate a sound understanding of typical aerospace materials.
- Students will demonstrate a sound understanding of material failure modes.
- Students will demonstrate a sound understanding of the characteristics of thin walled aerospace structures.
- Students will demonstrate a sound understanding of mechanical and adhesive joints.
- Students will demonstrate a sound understanding of aero-elasticity.
- Students will demonstrate a sound understanding of testing and characterization of materials and structures.
- Students will demonstrate a sound understanding of manufacturing principles and technology used in aerospace industry.
- Students will demonstrate the ability to analyze aerospace structures.
- Students will demonstrate the ability to design aerospace structures.
- Students will demonstrate the ability to analyze steady gliding, horizontal and climbing flight, analyze turning performance (three dimensional equations of motion, coordinate systems, Euler angles, transformation matrices).
- Students will demonstrate the ability to estimate airfield performance (take-off and landing).
- Students will demonstrate the ability to analyze unsteady climb and descent (including minimum time to climb problem);
- Students will demonstrate the ability to analyze cruise flight and transport performance.
- Students will demonstrate the ability to develop equations of motion with a wind gradient present.
- Students will have a basic understanding of how complex aerodynamic problems can be solved with the finite element method.
- Students will demonstrate a sound understanding of how static structural problems can be solved with the finite element method.
- Students will demonstrate a sound understanding of the interaction between aerodynamic loads, structural deformations and structural instability.
- Students will demonstrate an in-depth understanding of compressible flows.

- Students will demonstrate a basic understanding of turbulent flow analysis.
- Students will demonstrate an in-depth understanding of thermodynamics.
- Students will demonstrate an in-depth understanding of fatigue.
- Students will demonstrate a basic understanding of buckling of plates and shells.
- Students will demonstrate an in-depth understanding of composite material design and analysis.
- Students will demonstrate a thorough understanding of manufacturing technology.
- Students will demonstrate a sound understanding of energy sources and power generation in current and future propulsion systems for air and space applications.
- Students will demonstrate a sound understanding of the working concepts of aircraft and rocket engines with emphasis on the performance and characteristics of various types of propulsion systems, including turbojet, turbofan, turboprop, ramjet, scramjet and liquid and solid propellant rockets.
- Students will demonstrate the ability to characterize and analyze propulsion systems based on thermodynamics, chemistry, fluid mechanics and combustion fundamentals.
- Students will demonstrate understanding of longitudinal, lateral and directional aircraft stability.
- Students will demonstrate understanding of longitudinal, lateral and directional control systems.
- Students will demonstrate understanding of control theory applied to aerospace systems.
- Students will demonstrate the ability to derive mathematical models (plant models) that govern flight for various aerospace systems such as airplanes, helicopters and satellites.
- Students will demonstrate the ability to create control laws for stable flight.

## Degree Requirements

An M.S. student must take a minimum of 24 hours of graded graduate courses and 6 hours of thesis credits leading to a thesis. For the M.S. degree, the student must take five required courses. All remaining course work must be taken from an approved list of courses, which includes engineering and mathematics courses numbered 500 or above. Other courses must be approved by the student's advisor and the graduate studies committee. All candidates for the M.S. degree must complete comprehensive assessment that is distinct from program course requirements.

## Program of Study for the Masters Program in Aerospace Engineering: Proposed Curriculum

### Required Courses

All M.S. and M.E. candidates in Aerospace Engineering will be required to take the five (5) core courses listed below:

Course	Title	Credits
EMCH 508	Finite Element Analysis in Mechanical Engineering	3
EMCH 577	Aerospace Structures I	3
EMCH 744	Aerodynamics & Flight Mechanics	3
EMCH 585	Introduction to Composite Materials	3

EMCH 721	Aeroelasticity	3
<b>Total Credit Hours</b>		<b>15</b>

### Elective Aerospace Courses

All students in Aerospace Engineering must take a minimum of two (2) courses from the following courses:

Course	Title	Credits
Select at least two of the following:		
EMCH 743	Aircraft and Rocket Propulsion	6
EMCH 777	Aerospace Structures II	
EMCH 522	Design for Manufacture and Assembly	
EMCH 544	Compressible Fluid Flow	
EMCH 516	Control Theory in Mechanical Engineering	
EMCH 532	Intermediate Dynamics	
EMCH 571	Mechanical Behavior of Materials	
EMCH 701	Methods of Engineering Analysis	
ENCP 707	Continuum Mechanics	
ECHE 721	Advanced Heat Flow Analysis	
EMCH 751	Advanced Heat Transfer	
EMCH 741	Viscous and Turbulent Flow	
EMCH 794	Thermodynamics	
EMCH 785	Design of Composite Materials for Aerospace Structures	
EMCH 881	Fatigue of Materials	
<b>Total Credit Hours</b>		<b>6</b>

### Other Elective Courses

All remaining work must be taken from an approved list of courses which currently includes all engineering courses numbered 500 or above and math courses numbered 700 or above. Business courses numbered 500 or above may be taken with advance approval by the advisor and the Graduate Studies Committee. Other courses will be added to the list as approved by the faculty.

## Additional Program of Study Requirements

### Course and Program Grades

Courses **not** satisfying the requirements for a graduate degree are:

1. Any course with a grade of D+, D or F.
2. More than 12 credits with grade of C+ or below (the 4-C Rule).
3. Any course taken on a non-letter grade basis (except thesis).
4. More than 12 semester hours of credits from a previous graduate degree program.

The student must **maintain a minimum grade point average of 3.0** in:

1. All courses taken as part of the official degree program.
2. All courses numbered 700 or above.
3. All courses taken for graduate credit, including those not included in the official degree program.
4. Pass/Fail – A "fail" grade counts toward the 4-C rule.

### Publication Requirement for M.S. Students

An educational objective for M.S. students is that they have the ability to communicate their research results through oral presentations and written publications. Consistent with this objective, an M.S. student is required to submit, based on research performed while at USC, at least

one conference paper (or abstract with presentation) or one journal paper prior to graduation.

### Master's Thesis

A thesis is required of all students seeking the M.S. degree. The student's academic advisor must approve the subject of the thesis. The Graduate School will furnish general thesis regulations upon request. Any student who wishes to use University facilities or to confer with the faculty on thesis work must be officially enrolled for thesis credit.

### Thesis Committee

A student's M.S. Thesis Committee consists of the student's advisor and the second reader of the student's thesis.

### Thesis Presentation and Defense

The thesis presentation is to be open to all members of the University community and guests. During the Fall and Spring semesters, the presentation and defense are to be conducted during normal business hours and on a day that faculty are expected to be on campus. The Graduate Director must approve the date and time of presentations given during the summer sessions.

### Comprehensive Examination

A comprehensive examination covering the major field of study is required of all candidates for the M.S. degree, which is conducted immediately following the thesis defense. The student's thesis committee administers this exam.