Aerospace engineers create highly complex systems that operate in atmospheric environments (aeronautics) and/or in space environments (astronautics). Aerospace engineering is that branch of engineering that focuses on the design, development, testing, production and operation of aircraft, spacecraft and missiles. The design of an atmospheric flight vehicle requires that the aerospace engineer have a fundamental understanding of aerodynamics, aircraft structures, flight dynamics & controls and propulsion as well as a strong understanding of how each can affect the others. Similarly, the design of a spacecraft requires that an aerospace engineering have a fundamental understanding of orbital mechanics, the space environment, attitude determination & control, telecommunications, space structures and rocket propulsion, as well as an understanding of how each can affect the others. Given the complexity of modern aerospace systems, aerospace engineers increasingly make extensive use of computational modeling & simulation tools and are at times required to develop new computational tools, i.e. are required to be proficient in computer programming (coding). The emphasis on highly integrated systems and computational modeling & simulation make aerospace engineers competitive and sought out in professional fields not commonly associated with the discipline. In fact, The University of Alabama’s Bachelor of Science in Aerospace Engineering program was recently acknowledged for providing our students “with a strong multidisciplinary background that qualifies them to work in a variety of different disciplines”.

As one might guess from the name, the Department of Aerospace Engineering & Mechanics is also home to faculty members with expertise in engineering science & mechanics. The discipline of engineering mechanics focuses on the underlying physical principles responsible for the fundamental behavior fluid and solid materials exhibit. Such an understanding is critical to the development of cutting-edge technology. At the undergraduate level, students are exposed to engineering mechanics via courses in statics, dynamics, mechanics of materials, and fluid mechanics. The material covered in these courses represents the foundation on which a strong engineering education is built. Most engineering disciplines require students to take several engineering mechanics courses in preparation for future study in their chosen professional area.

The undergraduate curriculum in the Department of Aerospace Engineering & Mechanics leads to a Bachelor of Science in Aerospace Engineering (BSAE) degree and provides a background in the basic sciences, engineering sciences, humanities, applied analysis and design. Graduates with a suitable academic record are also prepared to pursue advanced degrees in aerospace engineering, engineering science & mechanics, other related engineering/technical fields of study and professional areas such as law and medicine.

Program Objectives
Graduates of the Bachelor of Science in Aerospace Engineering (BSAE) program are expected within a few years after graduation to have:

1. Established themselves as practicing professionals or pursued advanced study in aerospace engineering (or other professional fields of interest),
2. Demonstrated their ability to work successfully as a member of a professional team and function effectively as responsible professionals, and
3. Engaged in professional service (professional societies and/or community service).

Aerospace Engineering Curriculum

<table>
<thead>
<tr>
<th>Program Year</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshman</td>
<td>AEM 121</td>
<td>Engineering Mechanics I</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>CH 101</td>
<td>Engineering Mechanics II</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>EN 101</td>
<td>Engineering Mechanics III</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>ENGR 103</td>
<td>Engineering Mechanics IV</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>MATH 125</td>
<td>Engineering Mechanics V</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Sophomore</td>
<td>AEM 201</td>
<td>Engineering Mechanics VI</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>AEM 249</td>
<td>Engineering Mechanics VII</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>MATH 227</td>
<td>Engineering Mechanics VIII</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>MATH 237</td>
<td>Engineering Mechanics IX</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>PH 106</td>
<td>Engineering Mechanics X</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>Junior</td>
<td>AEM 313</td>
<td>Engineering Mechanics XI</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>AEM 341</td>
<td>Engineering Mechanics XII</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>AEM 349</td>
<td>Engineering Mechanics XIII</td>
<td>3</td>
</tr>
</tbody>
</table>

All students must complete a sequence of two of the HI/JSB or HUL/FA elective courses from the same department.


3. Students may satisfy this requirement by successfully completing either AEM 420 Computational Fluid Dynamics or AEM 461 Computational Methods for Aerospace Structures. Consult http://courseleaf.ua.edu/engineering/ for pre/co-requisites.

4. Specific aerospace engineering and mechanics electives are offered regularly, but not necessarily every year. Undergraduate students with the required academic credentials may qualify to enroll in 500-level courses.

5. The College of Engineering enforces a C- or higher requirement for any course that is a pre-requisite for another required course.

6. Taking the Fundamentals of Engineering (F.E.) examination is a departmental requirement for graduation with a BSAE degree.

Program Major Policy

Minor in Aerospace Engineering
A Minor in Aerospace Engineering requires the completion of a minimum of 20 hours including the following courses plus the required prerequisites:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEM 250</td>
<td>Mechanics Of Materials I</td>
<td>3</td>
</tr>
<tr>
<td>AEM 251</td>
<td>Mechanics Of Materials I Lab</td>
<td>1</td>
</tr>
<tr>
<td>AEM 264</td>
<td>Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>AEM 311</td>
<td>Fluid Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>AEM 313</td>
<td>Aerodynamics</td>
<td>3</td>
</tr>
<tr>
<td>AEM 341</td>
<td>Aircraft Structural Analysis</td>
<td>3</td>
</tr>
<tr>
<td>AEM 368</td>
<td>Flight Dynamics &amp; Control I</td>
<td>4</td>
</tr>
</tbody>
</table>

*These mechanics courses have AEM 201 Statics and various Math prerequisites.
**These two courses have prerequisites required of BSAE students but not necessarily of students from other degree programs. No equivalent for AEM 249 Algorithm Devl Implementation is required of non-BSAE students. ME 349 Engineering Analysis may substitute for AEM 349 Engineering Analysis for BSME students as a prerequisite for AEM 368 Flight Dynamics & Control I. Other students will need to have a numerical analysis/algorithms background for AEM 368 Flight Dynamics & Control I. Suitability of a student’s background will be determined by the AEM department on a case-by-case basis.

Minors for College of Engineering Students
A student majoring in an engineering program may earn a minor in engineering or another division of the University. Examples are chemistry, mathematics and physics, which are offered by the College of Arts and Sciences, and the general business minor offered by the Culverhouse College of Commerce and Business Administration. Required courses and electives needed for an engineering or computer science degree may also count toward the minor. For additional
information about minors and the courses required in them, see the appropriate sections of the undergraduate catalog.

Academic Policies for Minors
Academic criteria for a minor are determined by the division and program offering the minor. This includes prerequisite rules, minimum grade point average and any academic standards. When a minor is optional, a student can withdraw from the minor at any time. Any minor attempted by a College of Engineering student must be completed at the time a Bachelor of Science degree is awarded. A student’s graduation will not be delayed to complete an optional minor unless the student notifies the Engineering Registrar prior to the degree certification deadline. Each College of Engineering department program should maintain a list of minor courses in their programs, together with effective dates, even if all courses in a program can be used in the minor.

Procedure for Minor Selection by Engineering Students
1. Log in to your myBama account.
2. Select the Student tab.
3. Click Change of Major/Minor Application.
4. Click Change Program.
5. Select a minor from the menu.
6. Click Continue.

Minor in Engineering for Other Students
Two types of minors in the College of Engineering are available to students enrolled in other divisions of the University. The minors require a minimum of 18 hours in engineering courses. The Type 1 minor is a specialized program in any of the College’s engineering disciplines. Course requirements and advising are available from the appropriate department head, who will appoint an adviser for a student desiring this type of minor. The Type 2 minor is a general minor in engineering. The associate dean of engineering appoints an adviser for a student pursuing a Type 2 minor, which requires a minimum of 18 hours in courses chosen from a list available from the associate dean for Academic Programs.

University Scholars Program
The University Scholars Program allows gifted and highly motivated undergraduate students the opportunity to work simultaneously on a bachelor’s and master’s degree.

Eligibility Requirements
Phase I: Contingent upon completion of 61 semester hours of study and with a grade point average of at least a 3.3, students are admitted to Phase I at the beginning of their junior year or recommendation of the AEM Department. During their junior year, students will take courses in their major field to prepare them for the work of Phase II.

Phase II: On completion of at least 91 hours (typically at the end of the junior year), a GPA of 3.3 or above, and recommendation by the AEM Department, students may apply for and be accepted for admission to the Graduate School. Upon admission to the Graduate School, students will begin a program of study leading to the master’s degree as approved by the AEM Department and the dean of the Graduate School. Students accepted into the program may receive dual credit for up to six hours of graduate (500-level and above) credit. Seniors are allowed to take up to nine hours of graduate credit.

For more information, contact the AEM Undergraduate Program Coordinator, Dr. Thomas Zeiler at 205.348.7305 or tzeiler@eng.ua.edu.

AEM Honors Program
Dr. Thomas Zeiler, Undergraduate Program Coordinator
205.348.7305; tzeiler@eng.ua.edu

The Department of Aerospace Engineering and Mechanics (AEM) Honors Program is part of the College of Engineering Honors Program (COEHP). It is designed to challenge exceptionally talented students with an enriched educational experience. Students completing the AEM Honors Program will be awarded a certificate and recognized at the Honors Day Ceremony in the student’s senior year.

Participation in the University Honors Program (UHP) is recommended but not a requirement. It is also possible for a student in the AE Honors Program to participate in the AEM University Scholars Program; visit aem.eng.ua.edu/undergraduate/scholars-program for more information.

Eligibility Requirements
- must be a current UA aerospace engineering student
- must apply to the program
- must have a minimum 3.3 GPA (freshmen and transfer students must have a minimum 3.3 GPA on a 4.0 scale and an ACT score of 28 or SAT score of 1240; students not meeting this requirement may enter the program after they achieve a 3.3 GPA at the University)
- Honors students must maintain a minimum 3.3 GPA to remain in the AE Honors Program

AEM Honors Program Requirements
Eighteen hours of Honors credits are required, with 12 hours minimum that may include either approved AEM graduate or 400-level courses taken as Honors-By-Contract. Three of these 12 hours must be "experience-based***.

Approved Graduate Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEM 500</td>
<td>Intermediate Fluid Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>AEM 508</td>
<td>Propulsion Systems</td>
<td>3</td>
</tr>
<tr>
<td>AEM 513</td>
<td>Compressible Flow</td>
<td>3</td>
</tr>
<tr>
<td>AEM 514</td>
<td>Experimental Aerodynamics</td>
<td>3</td>
</tr>
<tr>
<td>AEM 520</td>
<td>Computational Fluid Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>AEM 528</td>
<td>Space Propulsion</td>
<td>3</td>
</tr>
<tr>
<td>AEM 552</td>
<td>Composite Materials</td>
<td>3</td>
</tr>
<tr>
<td>AEM 567</td>
<td>Orbital Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>AEM 570</td>
<td>Mechanical Vibrations</td>
<td>3</td>
</tr>
<tr>
<td>AEM 571</td>
<td>Fundamentals Of Acoustics</td>
<td>3</td>
</tr>
<tr>
<td>AEM 574</td>
<td>Structural Dynamics</td>
<td>3</td>
</tr>
</tbody>
</table>

*400-Level AEM courses taken as Honors-By-Contract, require completion of work deemed by the instructor to be more advanced than the usual course content. The Honors agreement must be established before the course begins.

**The "experience-based" requirement may be met by or AEM 492 Special Problems by arrangement with AEM faculty.

Other Honors Classes
A minimum of six additional hours of Honors classes must be taken that may include additional AEM Honors courses, CBH (Computer Based Honors) classes, UHP or IHP (International Honors Program) courses. If these six hours are designated UHP courses, the student will be recognized as completing UHP as well as COEHP requirements.

Faculty

Department Head
Baker, John
William D. Jordan Chair Professor
Roy, Samit

Professors
Barkey, Mark E.
Jackson, John E., Jr.
Karr, Charles L.

Associate Professors
Cheng, Gary
Haque, Anwarul
Hubner, James Paul
Lang, Amy W.
Olcmen, Semih
Sharif, Muhammad Ali Rob
Whitaker, Kevin W.
Zeiler, Thomas A.

Assistant Professors
Branam, Richard
O’Neill, Charles
Mulani, Sameer
Shen, Jinwei
Su, Weihua
Unnikrishnan, Vinu
Professors Emeriti
Gambrell, Samuel, Jr.
Jones, Stanley E.

Adjunct Instructors
Cooper, Steve
Highamith, Alton

Courses

AEM 120. Aerospace Science For Educators. 4 sem. hrs.
Students develop meaningful understanding and use of engineering and science knowledge and critical-thinking skills and come to appreciate engineering and science as part of the daily life of a scientifically literate professional.

AEM 121. Introduction to Aerospace Engineering I. 1 sem. hr.
To survey aerospace history, discuss pertinent topics and introduce basic concepts that promote an understanding of aerospace engineering and the profession. Prerequisite(s) with concurrency: MATH 125 and MATH 145.

AEM 201. Statics. 3 sem. hrs.
Forces and couples and resultants of force systems, free-body diagrams, equilibrium, and problems involving friction; and centroids, center of gravity, and distributed forces. Prerequisite(s): MATH 125 or MATH 145; and PH 125 or PH 105 and ENGR 151 or ENGR 103.

AEM 249. Algorithm Devl Implementation. 2 sem. hrs.
Algorithm development, numerical solution of engineering problems, and structured problem solving in C++. Prerequisite(s) with concurrency: MATH 125 and MATH 145.

Concepts of stress and strain; analysis of stresses and deformation in bodies loaded by axial, torsional, and bending loads; combined loads analysis; statically indeterminate members; thermal stresses; columns; and thin-walled pressure vessels. Prerequisite(s): MATH 126 or MATH 146 and AEM 201.

AEM 251. Mechanics Of Materials I Lab. 1 sem. hr.
Mechanical tests of metallic and nonmetallic materials in the elastic and inelastic ranges; use of materials testing for acceptance tests, for the determination of properties of materials, and for illustration of the validity of assumptions made in mechanics of materials. Prerequisite(s) with concurrency: AEM 250.

AEM 264. Dynamics. 3 sem. hrs.
Kinematics of particles and rigid bodies, Newton’s laws of motion, and principles of work-energy and impulse-momentum for particles and rigid bodies. Prerequisite(s): MATH 126 or MATH 146; and AEM 201.

AEM 311. Fluid Mechanics. 3 sem. hrs.
Fluid statics, application of conservation laws to simple systems, dimensional analysis and similitude, and flow in open and closed conduits. Prerequisite(s): MATH 227 or MATH 247; and AEM 201.

AEM 313. Aerodynamics. 3 sem. hrs.
Introductory aerodynamics, including properties of the atmosphere; aerodynamic characteristics of airfoils, wings, propellers, and other components; drag phenomena; and topics of current interest. Prerequisite(s): AEM 311 and AEM 264 and MATH 238.

AEM 341. Aircraft Structural Analysis. 3 sem. hrs.
Methods of analyzing stressed skin structures of the types that are typically found in aircraft, missiles and space vehicles. Unsymmetrical bending and bending and twisting of multiple cell structures are also covered. Prerequisite(s): AEM 249 and AEM 250.

AEM 349. Engineering Analysis. 4 sem. hrs.
Elements of analytical and numerical analysis with engineering applications including, but not limited to, differential equations, linear algebra, root-finding, Gaussian elimination, and Runge-Kutta integration. Prerequisite(s): MATH 237 and MATH 238 and AEM 249.

AEM 360. Astronautics. 3 sem. hrs.
Survey of topics and basic concepts in astronautics: orbital mechanics, space environment, attitude determination & control, telecommunications, space structures, rocket propulsion, and spacecraft systems. Prerequisite(s): MATH 238 and AEM 311.

AEM 368. Flight Dynamics & Control I. 4 sem. hrs.
Fundamentals of airplane aerodynamics and performance, static trim, 6-DOF equations of motion, and flight dynamics, stability and control. Prerequisite(s): AEM 313 and AEM 349.

AEM 402. Integrated Aerospace Design I. 3 sem. hrs.
Preliminary design techniques for an aerospace system. Prerequisite(s): AEM 341 and AEM 368 and AEM 413.

AEM 404. Integrated Aerospace Design II. 3 sem. hrs.
Preliminary and detailed design of aircraft and space vehicles, including weight and balance, power plant selection, exterior layout, performance, stability, and control. Involves group efforts on selected projects. Prerequisite(s): AEM 402.

AEM 408. Propulsion Systems. 3 sem. hrs.
Basic propulsion dynamics, thermodynamics of fluid flow, combustion kinetics, air-breathing engines, rockets, design criteria, performance and advanced propulsion systems. Prerequisite(s): AEM 413.

AEM 413. Compressible Flow. 3 sem. hrs.
Dynamics of compressible fluids: shock waves, one-dimensional flow, expansion waves in two-dimensional flow and compressible flow over aerodynamic bodies. Prerequisite(s): AEM 311 and ME 215.

AEM 414. Experimental Aerodynamics. 3 sem. hrs.
This course provides a laboratory counterpoint to concepts discussed in aerodynamics and fluid mechanics. Course topics include statistical and uncertainty analysis techniques, design of experiments, computer-based data-acquisition, sensors for fluid mechanic measurements, and aerodynamic measurement techniques and facilities. Prerequisite(s): AEM 313.

AEM 416. Helicopter Theory. 3 sem. hrs.
Critical examination of the propulsive airscrew, including induced velocity relations, flow patterns, and similarity. Practical applications are approached through existing theory and practice. Prerequisite(s): MATH 238 and AEM 264 and AEM 311.

AEM 420. Computational Fluid Dynamics. 3 sem. hrs.
Introduction to basic mathematical concepts and engineering problems associated with numerical modeling of fluid systems. Application of the state of the art numerical models to engineering problems. Fundamentals of Finite Difference and Finite Volume Methods and their applications in fluid dynamics and heat transfer problems will be covered. Prerequisite(s): AEM 311 and AEM 349 and MATH 238.

AEM 428. Space Propulsion. 3 sem. hrs.
This course introduces the student to descriptions and analyses of space and launch-vehicle propulsion. Topics covered include advanced schemes such as nuclear, solar and laser propulsion; power cycles; and tether systems. Prerequisite(s): AEM 408.

AEM 448. Stochastic Mechanics. 3 sem. hrs.
This course develops, analyzes and discusses the application of uncertainty quantification in engineering systems and design methodologies to include uncertainties in the systems. Topics include: classification of uncertainties and methods of quantification, perturbation approaches, polynomial chaos, sampling techniques, random processes and Bayesian analysis. Prerequisite(s): GES 255.

Design of tension, compression bending, torsion, and stiffened panel members; experimental and analytical investigations involving static and dynamic structural behavior. Writing proficiency is required for a passing grade in this course. Prerequisite(s): AEM 401.

AEM 452. Composite Materials. 3 sem. hrs.
First exposure to composite materials. Focus on how heterogeneity/anisotropy in composites influence thermomechanical behavior. The behavior of both continuous and short fiber reinforced composites will be emphasized. Stress analysis for design, manufacturing processes and test methods of composite materials will be covered. Prerequisite(s): AEM 250 and AEM 341 or GE 331 or ME 350.

AEM 461. Computational Methods for Aerospace Structures. 3 sem. hrs.
Development of the fundamentals of the finite-element method from matrix and energy methods. Use of the finite-element method for detailed design of aerospace structures. Modeling techniques for static and dynamic analyses. Prerequisite(s): MATH 227 or MATH 247, AEM 341 and AEM 349.

AEM 468. Flight Dynamics & Control II. 4 sem. hrs.
Linear equations of motion, dynamic response, state-space methods and fundamentals of classical and modern control theory; flying and handling qualities design criteria; stability augmentation and control augmentation. Computing proficiency is required for a passing grade in this course. Prerequisite(s): AEM 368.
AEM 469. Orbital Mechanics. 3 sem. hrs.
Introduction to engineering application of celestial mechanics; high-speed, high-altitude aerodynamics; and other fields related to the contemporary problems of space vehicles. Fundamentals of applied dynamics, nomenclature of space flight, space environment and solar system, and two-body orbits. Kepler’s laws, coordinate transformations, and related studies.
Prerequisite(s): MATH 238 and AEM 264.

AEM 470. Mechanical Vibrations. 3 sem. hrs.
Free and forced vibrations, both undamped and damped. Systems with many degrees of freedom are formulated and analyzed by matrix methods. Experimental techniques of vibration measurement are introduced.
Prerequisite(s): AEM 264 and MATH 238 and AEM 250.

AEM 471. Fundamentals Of Acoustics. 3 sem. hrs.
Fundamental physical principles underlying wave propagation and resonance in mechanical systems. Introduces applications and provides experience in acoustic and audio measurements and the associated instrumentation.
Prerequisite(s): MATH 238 and PH 106 and ECE 320.

AEM 474. Structural Dynamics. 3 sem. hrs.
Theoretical foundations of structural dynamics and application of methods to modeling, analysis, and design.
Prerequisite(s): AEM 250 and AEM 264 and MATH 237 and MATH 238.

AEM 481. Complex Engineering Systems. 3 sem. hrs.
Introduction to the concepts and techniques associated with the analysis of complex systems, dynamic systems, chaos, lumped parameter modeling, feedback, networks, thermal/electrical circuit analogies, entropy.
Prerequisite(s): AEM 349 or ME 349, ME 215, MATH 238.

AEM 484. Space Environment. 3 sem. hrs.
This course provides an introduction to the effects of the space environment on spacecraft. The harsh space environment introduces several unique challenges to the spacecraft designer. Focus on the impact of this environment and how best to mitigate these effects through early design choices will give the satellite designer better tools. Topics include: geomagnetic field, gravitational field of the Earth, Earth’s magnetosphere, vacuum, solar UV, atmospheric drag, atomic oxygen, free and trapped radiation particles, plasma, spacecraft charging, micrometeoroids.

AEM 491. Special Problems. 1-6 sem. hr.
Assigned problems are explored on an individual basis. Credit is based on the amount of work undertaken.

AEM 492. Special Problems. 3 sem. hrs.
Assigned problems are explored on an individual basis. Credit is based on the amount of work undertaken.

AEM 495. Senior Seminar. 2 sem. hrs.
Selected topics from recent developments in the aeronautical and space engineering fields. There are visiting lecturers and extensive student participation. Several nontechnical topics of immediate interest to seniors are explored. Each student must complete a personal resume. Writing proficiency within this discipline is required for a passing grade in this course.
Prerequisite(s) with concurrency: AEM 402.