Mechanical and Aerospace Engineering

Web Site: http://www.odu.edu/mae

Sebastian Bawab, Chair
Colin Britcher, Associate Chair

The Mechanical and Aerospace Engineering (MAE) Department offers an undergraduate program leading to a Bachelor of Science in Mechanical Engineering. The program is accredited by the Engineering Accreditation Commission (EAC) of ABET, http://www.abet.org. The Department also offers varied programs of graduate study and research leading to the Master of Engineering, Master of Science, Doctor of Engineering and Doctor of Philosophy degrees in either Mechanical Engineering or Aerospace Engineering. For further information, please visit the Department's web site: www.eng.odu.edu/mae.

Mechanical Engineering Mission

1. To develop and maintain a high quality undergraduate program of study leading to the bachelor's degree in Mechanical Engineering.
2. To develop and maintain high quality graduate programs of study and research leading to master's and doctoral degrees in Mechanical Engineering or Aerospace Engineering.
3. To conduct a relevant and high quality research program in the mechanical and aerospace engineering disciplines.
4. To provide practicing mechanical and aerospace engineers in Virginia the opportunities to develop and maintain up-to-date technical knowledge and skills.
5. To provide the unique skills and knowledge required by the mechanical and aerospace engineering professions to support existing government agencies, consulting firms and industry and help promote the development of new and more competitive industries in Virginia and the nation.

Bachelor of Science in Mechanical Engineering

Sushil Chaturvedi, Chief Departmental Advisor

The mechanical engineering program is among the most basic of all engineering programs, with a curriculum that embraces the major areas of power, design, and fluid or solid mechanics. Seniors may enroll in one of three identified concentration areas, or may select a custom set of courses:

1. Power/energy conversion
2. Mechanical systems/design
3. Aerospace engineering

The program is designed to prepare its graduates for professional practice in many facets of engineering, such as research, development, design, planning, testing, management, and consulting. The graduate is prepared to undertake challenging and creative engineering work in almost any industry, government agency, research organization, or consulting firm. The program also provides an excellent preparation for graduate school and the Fundamentals of Engineering (FE) Exam.

An undergraduate student handbook providing rules and a detailed semester-by-semester plan for the program is available on the department's web site. Courses are routinely scheduled in the late afternoon and evening to accommodate students with current employment.

Outcomes

The Mechanical and Aerospace Engineering Department has adopted, after deliberations by its constituents, 7 outcomes for the BSME program. These outcomes are listed below. The students who qualify for graduation will:

1. Be able to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. Be able to apply the engineering design process to produce solutions that meet specified needs with consideration for public health and safety, and global, cultural, social, environmental, economic, and other factors as appropriate to the discipline.
3. Be able to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
4. Communicate effectively with a range of audiences.
5. Recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
6. Recognize the ongoing need to acquire new knowledge, to choose appropriate learning strategies, and to apply this knowledge.
7. Function effectively as a member or leader of a team that establishes goals, plans tasks, meets deadlines, and creates a collaborative and inclusive environment.

Mechanical Engineering Objectives

The program's educational objectives describe the career and professional accomplishments that the program is preparing graduates to attain within a few years after graduation. The educational objectives of the mechanical engineering program, established with participation of all constituencies, are consistent with the mission of Old Dominion University and the Department of Mechanical and Aerospace Engineering.

The objectives of the mechanical engineering undergraduate program at Old Dominion University are that our graduates should accomplish the following:

1. To establish themselves as successful professionals in the general areas of thermal/ fluid systems, mechanical systems and design, and materials and manufacturing in industry and government settings by demonstrating their ability to:
   a. Conduct themselves consistently in a responsible, professional and ethical manner.
   b. Participate in continuing education, research and development, and in other lifelong creative efforts in science and technology.
   c. Lead others in support of activities that promote service to, and economic development of, the community, the region, state and nation.

2. To successfully pursue and complete graduate programs in mechanical engineering, aerospace engineering or a related field if they so desire.

Accreditation

The Bachelor of Science in Mechanical Engineering is accredited by the Engineering Accreditation Commission of ABET www.abet.org. (http://www.abet.org)

Four-Year Plan - Mechanical Engineering - BSME (http://catalog.odu.edu/undergraduate/frankbattencollegeofengineeringandtechnology/mechanicalaerospaceengineering/mechanicalengn-bsme-fouryearplan)

This is a suggested curriculum plan to complete this degree program in four years. Please consult information in this Catalog, Degree Works, and your academic advisor for more specific information on course requirements for this degree.

Mechanical Engineering Four-Year Plan*

<table>
<thead>
<tr>
<th>Freshman</th>
<th>First Term</th>
<th></th>
<th>Hours</th>
<th>Second Term</th>
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<th>Hours</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>MATH 211 (grade of C or better required)</td>
<td>4</td>
<td>MATH 212 (grade of C or better required)</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>
### Junior

<table>
<thead>
<tr>
<th>First Term</th>
<th>Hours</th>
<th>Second Term</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>MAE 303 (grade of C or better required)</td>
<td>3</td>
<td>MAE 312</td>
<td>3</td>
</tr>
<tr>
<td>MAE 305</td>
<td>1</td>
<td>MAE 332 (grade of C or better required)</td>
<td>3</td>
</tr>
<tr>
<td>MAE 311 (grade of C or better required)</td>
<td>3</td>
<td>MAE 315</td>
<td>3</td>
</tr>
<tr>
<td>MAE 340</td>
<td>3</td>
<td>MAE 336</td>
<td>3</td>
</tr>
<tr>
<td>Literature Way of Knowing</td>
<td>3</td>
<td>Philosophy and Ethics Way of Knowing **</td>
<td>3</td>
</tr>
<tr>
<td>Human Creativity Way of Knowing</td>
<td>3</td>
<td>Human Behavior Way of Knowing</td>
<td>3</td>
</tr>
</tbody>
</table>

### Senior

<table>
<thead>
<tr>
<th>First Term</th>
<th>Hours</th>
<th>Second Term</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td>MAE 433</td>
<td>3</td>
<td>MAE 435</td>
<td>3</td>
</tr>
<tr>
<td>MAE 434W (grade of C or better required)</td>
<td>3</td>
<td>MAE Option Course</td>
<td>3</td>
</tr>
<tr>
<td>MAE 436</td>
<td>3</td>
<td>MAE Option Course</td>
<td>3</td>
</tr>
</tbody>
</table>

### Total credit hours: 128

* Does not include the University's General Education language and culture requirement. Additional hours may be required.

** ENMA 480 is preferred.

### Senior Concentrations

1. Power/Energy - Three courses from MAE 411, MAE 412, MAE 413, MAE 414, MAE 417, MAE 438, MAE 440.
2. Mechanical Systems Design - Three courses from MAE 404, MAE 422, MAE 431, MAE 438, MAE 440, MAE 441.
3. Aerospace - Three courses from MAE 403, MAE 406, MAE 417, MAE 420 (or MAE 440), MAE 438 or MAE 460.

Students may also select alternative combinations of 300/400-level courses, in which case they will be considered to have an "undesignated" concentration.

### Continuance Regulations

It is the policy of the Department of Mechanical and Aerospace Engineering to deny a student eligibility to enroll in program courses after it becomes evident that he or she is either unable or unwilling to maintain reasonable standards of academic achievement. Required courses are all those specifically listed above. Major GPA is calculated based on courses with an MAE prefix.

1. Warning. A student will be placed on departmental academic warning if his or her major grade point average falls below 2.0 after six or more hours have been attempted in the major. Students on academic warning are expected to consult with their departmental advisors and to take immediate steps to improve their major GPA.
2. A student will be placed on departmental academic probation whenever his or her major grade point average falls below 2.00 for two consecutive semesters of enrollment. Students on academic probation are expected to improve their major GPA to 2.0 or above in no more
than one additional regular semester (Fall or Spring). University rules for grade forgiveness will apply.

3. A student is subject to termination from the program if his or her major GPA remains below 2.0 after the additional regular semester on probation.

4. Students are expected to achieve the required grade (i.e. pass or C) in all required courses in no more than three completed attempts. Failure to do so renders the student subject to immediate termination from the program.

Appeals of termination from the program are in order if extenuating circumstances warrant. Appeals are to be made in writing to the chair of the department. Once the appeal is submitted, it is considered by the faculty of the department.

**Minor in Aerospace Engineering**

The Department of Mechanical and Aerospace Engineering offers a minor program in aerospace engineering comprising four courses from the following list:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAE 403</td>
<td>Flight Mechanics</td>
<td>3</td>
</tr>
<tr>
<td>MAE 406</td>
<td>Flight Vehicle Aerodynamics</td>
<td>3</td>
</tr>
<tr>
<td>MAE 417</td>
<td>Propulsion Systems</td>
<td>3</td>
</tr>
<tr>
<td>MAE 420</td>
<td>Aerospace Structures</td>
<td>3</td>
</tr>
<tr>
<td>or MAE 440</td>
<td>Introduction to Finite Element Analysis</td>
<td>3</td>
</tr>
<tr>
<td>MAE 438</td>
<td>Applied Analog and Digital Control</td>
<td>3</td>
</tr>
<tr>
<td>MAE 460</td>
<td>Introduction to Space Systems Engineering</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Hours Required (choose 4 courses): 12

It may be possible to substitute other appropriate senior-level mechanical and aerospace engineering courses with prior approval of the Mechanical and Aerospace Engineering Department. The minor in aerospace engineering is open to all students except for those majoring in mechanical engineering with a concentration in aerospace engineering. All prerequisites and corequisites must be satisfied for all courses taken.

For completion of a minor, a student must have a minimum overall cumulative grade point average of 2.00 in all courses required for the minor exclusive of lower-level courses, prerequisites and corequisites and complete at least six hours of upper-level courses in the minor requirement through courses offered by Old Dominion University.

**Minor in Marine Engineering**

The minor in marine engineering is open to all students with the exception of those students in the Mechanical Engineering Technology program’s Marine Engineering option. Students seeking the minor must satisfy all pre- or corequisite requirements for the courses selected. The minor is multidisciplinary and consists of four courses in topics that are relevant to the shipbuilding, maintenance, repair and maritime operations industries.

The course requirements are as follows:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MET 475</td>
<td>Marine Engineering I</td>
<td>3</td>
</tr>
<tr>
<td>MET 476</td>
<td>Marine Engineering II</td>
<td>3</td>
</tr>
<tr>
<td>MAE 450</td>
<td>Principles of Naval Architecture</td>
<td>3</td>
</tr>
<tr>
<td>MAE 417</td>
<td>Propulsion Systems</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Hours 12

For completion of a minor, a student must have a minimum overall grade point average of 2.00 in all courses required for the minor exclusive of lower-level courses, prerequisites and corequisites and complete at least six hours of upper-level courses in the minor requirement through courses offered by Old Dominion University.

**Minor in Mechanical Engineering**

The Department of Mechanical and Aerospace Engineering offers a minor program with two emphases: thermal sciences and mechanics.

The specific minimum courses required are as follows:

**Thermal Sciences**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAE 303</td>
<td>Mechanics of Fluids</td>
<td>3</td>
</tr>
<tr>
<td>MAE 311</td>
<td>Thermodynamics I</td>
<td>3</td>
</tr>
<tr>
<td>MAE 312</td>
<td>Thermodynamics II</td>
<td>3</td>
</tr>
<tr>
<td>or MAE 414</td>
<td>Introduction to Gas Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>MAE 315</td>
<td>Heat and Mass Transfer</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Hours 12

**Mechanics**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAE 332</td>
<td>Mechanical Engineering Design I</td>
<td>3</td>
</tr>
<tr>
<td>MAE 340</td>
<td>Computational Methods in Mechanical</td>
<td>3</td>
</tr>
<tr>
<td>Engineering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAE 404</td>
<td>Vibrations</td>
<td>3</td>
</tr>
<tr>
<td>MAE 436</td>
<td>Dynamic Systems and Control</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Hours 12

It may be possible to substitute other appropriate junior- or senior-level mechanical engineering courses for those specified above with prior approval of the department. Exceptions are rare and not encouraged. All prerequisites and corequisites must be satisfied for all courses taken.

For completion of a minor, a student must have a minimum overall cumulative grade point average of 2.00 in all courses required for the minor exclusive of lower-level courses, prerequisites and corequisites and complete at least six hours in upper-level courses in the minor requirement through courses offered by Old Dominion University.

**Minor in Motorsports Engineering**

The Department of Mechanical and Aerospace Engineering offers a minor program in motorsports engineering. The minor is multidisciplinary and consists of four courses in topics that are relevant to the motorsports and automotive industries. Each course is practice-oriented and consists of integrated lectures and laboratories.

The course requirements are as follows:

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAE 407</td>
<td>Ground Vehicle Aerodynamics</td>
<td>3</td>
</tr>
<tr>
<td>MAE 457</td>
<td>Motorsports Vehicle Dynamics</td>
<td>3</td>
</tr>
<tr>
<td>or MET 427</td>
<td>Mechatronic System Design</td>
<td>3</td>
</tr>
<tr>
<td>MAE 467</td>
<td>Racecar Performance</td>
<td>3</td>
</tr>
<tr>
<td>MET 480</td>
<td>High Performance Piston Engines</td>
<td>3</td>
</tr>
<tr>
<td>or MAE 477</td>
<td>High Performance Piston Engines</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Hours 12

It may be possible to substitute other appropriate senior-level mechanical and aerospace engineering technology courses with prior approval of the Mechanical and Aerospace Engineering Department, but substitutions are rare. The minor in motorsports engineering is open to all students. All prerequisites and corequisites must be satisfied for all courses taken.

For completion of a minor, a student must have a minimum overall cumulative grade point average of 2.00 in all courses required for the minor exclusive of lower-level courses, prerequisites and corequisites and complete at least six hours in upper-level courses in the minor requirement through courses offered by Old Dominion University.

**MECHANICAL AND AEROSPACE ENGINEERING Courses**

MAE 111. Mechanical and Aerospace Engineering Information Literacy and Research. 2 Credits.

This course will introduce students to the needs, access, evaluation, use, impact and ethical/legal aspects of information, and to the application of information literacy and research in the fields of mechanical and aerospace engineering. Prerequisites: ENGN 110.
MAE 195. Topics. 1-3 Credits.
Permission of the chair required.

MAE 201. Materials Science. 3 Credits.
Principles of materials science with emphasis on the relationship between structure and properties and their control through composition and processing. Metals, polymers, ceramics, and composite materials are considered. Prerequisites: MATH 211 with a grade of C or better.

MAE 203. Mechanical Engineering Laboratory I - Materials Science. 1 Credit.
This laboratory involves experiments demonstrating lecture material covered in the MAE 201 course. Pre- or corequisite: MAE 201 and CS 150 or ENGN 150.

MAE 204. Engineering Mechanics I - Statics. 3 Credits.
Introduction to mechanical engineering problems and their solutions through the study of statics of particles and rigid bodies. Emphasis will be placed on the relationship of the static loads with the mechanical properties of the materials being considered. Introduction to the concepts of stress and strain and internal forces as applied to static bodies. Prerequisite: MATH 211 with a grade of C or better. Pre- or corequisite: PHYS 231N.

MAE 205. Dynamics. 3 Credits.
Introduction to engineering problems and their solutions through a study of the dynamics of particles and rigid bodies. General force systems are studied including friction. Prerequisite: A grade of C or better in MAE 204 or CEE 204. Pre- or corequisite: MATH 212.

MAE 220. Engineering Mechanics II - Solid Mechanics. 3 Credits.
Introduction to concepts of stress, strain and their relation to each other. Stress and strain in axially loaded members and circular rods and tubes subjected to torsion. Normal and shear stress in beams under bending loads. Additional topics include bending deflection, transformation of stress and strain, Mohr's circles, statically indeterminate problems, combined stress and thin walled pressure vessels. Prerequisite: A grade of C or better in MAE 204 or CEE 204.

MAE 225. Mechanical Engineering Laboratory II - Solid Mechanics. 1 Credit.

MAE 303. Mechanics of Fluids. 3 Credits.
Fundamental concepts, fluid statics, basic equations in integral form, open-channel flow, Bernoulli's equation, dimensional analysis and similitude, incompressible viscous flow, pipe friction, boundary layers, introduction to differential analysis. Prerequisites: MATH 307, MATH 312, and a grade of C or better in MAE 205.

MAE 305. Mechanical Engineering Laboratory III - Thermo/Fluids. 1 Credit.
An introduction to thermo-fluid experimentation and measurement; basic flow phenomena demonstrated; measurement techniques for flow temperature, pressure and properties; report writing and data reduction methods, including statistical treatment of data; formal oral reports. Prerequisite: Junior standing. Pre- or corequisite: MAE 303 and MAE 311.

MAE 311. Thermodynamics I. 3 Credits.
Essential definitions of thermodynamics, first law, physical properties, ideal and real gases, second law, reversibility, irreversibility and consequences of thermodynamic cycles. Prerequisites: MATH 312.

MAE 312. Thermodynamics II. 3 Credits.
Concepts and principles dealing with thermodynamic cycles, relations and generalized charts, mixtures of fluids, chemical reactions, chemical and phase equilibrium, thermodynamic aspects of fluid flow; introduction to compressible flow, isentropic and normal shock wave relations. Prerequisites: MATH 307, and a grade of C or better in MAE 303, and a grade of C or better in MAE 311.

MAE 315. Heat and Mass Transfer. 3 Credits.
Fundamental laws of heat transfer by conduction, convection, and radiation; boundary-layer concepts; simultaneous heat, mass, and momentum transfer. Prerequisites: A grade of C or better in MAE 303, and a grade of C or better in MAE 311.

MAE 332. Mechanical Engineering Design I. 3 Credits.
Introduction to machine design including review of stress and deflection analysis. Statistical considerations in design, strength of mechanical elements with emphasis on theories of failure and fatigue design. Prerequisites: MAE 201, a grade of C or better in MAE 205, a grade of C or better in MAE 220, and MET 120. Pre- or corequisite: MAE 225.

MAE 336. Electromechanical Systems. 3 Credits.
Introduction to analog and digital circuits; sensors, actuators and signals; laboratory instrumentation (oscilloscope, function generator, etc.); data acquisition; and embedded microcontroller systems. Students will perform electronics experiments as homework assignments. Prerequisites: CS 150 or ENGN 150 and PHYS 232N.

MAE 340. Computational Methods in Mechanical Engineering. 3 Credits.
A survey of modern computing techniques for mechanical engineers. Numerical algorithms are presented to solve practical problems in mechanical engineering as found in solid mechanics, fluid mechanics, dynamics, and heat transfer. Emphasis is on providing computational experience in applied numerical methods using computers. Topics include roots of equations, simultaneous equations, differentiation, integration, regression analysis, interpolation and differential equations. Analysis, understanding, and quantification of computational errors are included in all topics and applications. Prerequisites: ENGN 150 or CS 150, MATH 307 and MATH 312.

MAE 367. Cooperative Education. 1-3 Credits.
Available for pass/fail grading only. Student participation for credit based on the academic relevance of the work experience, criteria, and evaluative procedures as formally determined by the department and Career Development Services prior to the semester in which the work experience is to take place. Prerequisites: Approval by department and Career Development Services in accordance with the policy for granting credit for Cooperative Education programs.

MAE 368. Internship. 1-3 Credits.
Available for pass/fail grading only. Academic requirements will be established by the department and will vary with the amount of credit desired. Allows students to gain short duration career-related experience. Prerequisites: Approval by department and Career Development Services.

MAE 369. Practicum. 1-3 Credits.
Academic requirements will be established by the department and will vary with the amount of credit desired. Allows students an opportunity to gain short duration career-related experience. Prerequisites: Approval by department and Career Development Services.

MAE 403/503. Flight Mechanics. 3 Credits.
Aircraft concepts including performance prediction and optimization, flight and maneuver envelopes, and steady flight performance. Additional topics: longitudinal static stability and trim; aircraft dynamics; development, separation and solution of aircraft equations of motion; natural modes; dynamic stability; sensors and actuators; and design of stability augmentation and autopilot systems. Prerequisites: MAE 303 with a grade of C or better and MAE 340. Pre- or corequisite: MAE 436.

MAE 404/504. Vibrations. 3 Credits.
Free and forced vibrations of undamped and damped, single-degree of freedom, multi-degree of freedom, and continuous systems. Exact and approximate methods to find natural frequencies. Prerequisites: A grade of C or better in MAE 205, a grade of C or better in MAE 220, MAE 340 and MATH 312.
MAE 460/560. Introduction to Space Systems Engineering. 3 Credits.
Introduction to spacecraft systems starting from mission design and space environment considerations and proceeding through propulsion, altitude control, spacecraft structural design, thermal control, power and communications for spacecraft. Prerequisites: MATH 307 and PHYS 232N.

MAE 467/567. Racecar Performance. 3 Credits.
On-track performance of typical racecars (Legends and Baby Grand) to demonstrate and evaluate the interplay between vehicle aerodynamics, suspension system geometry adjustments, tire selection and operating pressure on overall racecar performance and handling. Laboratory testing via on-board instrumentation during skid pad and road course evaluation; computer simulation to investigate various car set-ups. Prerequisites: MAE 303 with a grade of C or better, or MET 330 and MAE 205 with a grade of C or better, or MET 310.

MAE 477/577. High Performance Piston Engines. 3 Credits.
A study of the fundamental principles and performance characteristics of spark ignition and diesel internal combustion engines. Overview of engine types and their operation, engine design and operating parameters; ideal and semi-empirical models of engine cycles; combustion, fluid flow and thermal considerations in engine design and performance. Laboratory evaluation of engine performance using flow and dynamometer systems. Prerequisites: MAE 312, MAE 315 or MET 300, MET 350.

MAE 495/595. Topics in Mechanical and Aerospace Engineering. 1-3 Credits.
Special topics of interest with emphasis placed on recent developments in mechanical and aerospace engineering or engineering mechanics. (offered fall, spring, summer) Prerequisites: Senior standing; Permission of the chair is required.

MAE 496. Topics in Mechanical and Aerospace Engineering. 1-3 Credits.
Special topics of interest with emphasis placed on recent developments in mechanical engineering or engineering mechanics. (offered fall, spring, summer) Prerequisites: senior standing; permission of the chair is required.

MAE 497/597. Independent Study in Mechanical and Aerospace Engineering. 1-3 Credits.
Individual analytical, computational, and/or experimental study in an area selected by student. Supervised and approved by the advisor. Prerequisites: Senior standing; Permission of the chair is required.