**Aerospace Minor**

The Mechanical and Industrial Engineering Department within the Norm Asbjornson College of Engineering offers a nonteaching minor in aerospace called the Aerospace Minor. This minor provides a suite of courses from a wide variety of disciplines which are relevant to aerospace. The minor requires a minimum of 31 credits. Required courses comprise 16 credits in four (4) specified courses, which are common to Mechanical Engineering, Electrical Engineering, Physics, Civil Engineering, Chemical Engineering, Chemistry, and Industrial & Management Systems Engineering at MSU Bozeman. An additional required course, EMEC 368 Introduction to Aerospace, is the cornerstone, foundational course for the Aerospace Minor. An additional 12 elective credits (minimum of four courses) are required from a specified list which comprises the Aerospace Elective Courses. This minor is a useful complement to majors in science or engineering for those seeking a cross-disciplinary academic program with topics in aerospace. The required courses are carefully selected to ensure that students seeking the Aerospace Minor at MSU have the requisite math and science background to engage in specific applications to aerospace. The Aerospace Elective Courses were developed to provide students with the minimum background of specific topics applicable to aerospace. These are Materials and Structures (needed for development of aerospace systems; structures, hardware, sensors, system packages, etc.), Thermo/Fluids (needed for an understanding of aeronautical systems, momentum equations relevant to propulsion systems, environmental needs, etc.), and Focused Topics (a series of focused and advanced topics applicable to aerospace. These courses include design, dynamics and control, Computer Aided Design (CAD), space science, etc.). The Certifying Officer for the Aerospace Minor is the current MSU Lyle A. Wood Distinguished Professor, and students with questions are encouraged to seek him/her by contacting the MSU Mechanical & Industrial Engineering Department.

The MSU Aerospace Minor = 19 required credits + 12 minimum elective credits = 31 minimum course credits for the Aerospace Minor: In some cases, this may be accomplished within the maximum 128 credits for certain B.S. degrees at MSU (with the Aerospace Minor inclusive). Students who have less than 19 course credits will fill the additional minimum 28 course credits with approved Aerospace Minor elective course credits. Students seeking a degree in ME or MET cannot use EMEC 368 as a Professional Elective for their major degree requirements.

### Required Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>M 171Q</td>
<td>Calculus I</td>
<td>3-4</td>
</tr>
<tr>
<td>or M 165Q</td>
<td>Calculus for Technology I</td>
<td></td>
</tr>
<tr>
<td>M 172</td>
<td>Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>or M 166</td>
<td>Calculus for Technology II</td>
<td></td>
</tr>
<tr>
<td>PHSX 220</td>
<td>Physics I with Calculus</td>
<td>4</td>
</tr>
<tr>
<td>or PHSX 205</td>
<td>College Physics I</td>
<td></td>
</tr>
<tr>
<td>PHSX 222</td>
<td>Physics II with Calculus</td>
<td>4</td>
</tr>
<tr>
<td>or PHSX 207</td>
<td>College Physics II</td>
<td></td>
</tr>
<tr>
<td>EMEC 368</td>
<td>Introduction to Aerospace</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Credit Sub-Total</td>
<td>17-19</td>
</tr>
</tbody>
</table>

### Aerospace Minor Courses

Students take one course from each category below, plus one additional course from any of the three categories (Materials and Structures, Thermo/Fluids, Focused Topics).

#### Materials and Structures

Choose at least one from the following:
- EELE 409  EF Material Science
- EMAT 350  Engineering Materials

#### Thermo/Fluids

Choose at least one from the following:
- ECHM 424  Transport Analysis
- EGEN 324  Applied Thermodynamics
- EGEN 335  Fluid Mechanics
- EGEN 435  Fluid Dynamics
- EMEC 326  Fundamentals of Heat Transfer
- EMEC 425  Advanced Thermal Systems
- EMEC 426  Thermodynamics of Propulsion Systems
- EMEC 430  Introduction to Combustion
- EMEC 436  Computational Fluid Dynamics
- ETME 423  Principles of HVAC II
- ETME 430  Fluid Power Systems Design

#### Focused Topics

Choose at least one from the following:
- EELE 308  Signals and Systems Analysis
- EELE 321  Introduction To Feedback Controls
- EELE 407  Intro To Microfabrication
- EELE 422  Intro to Modern Control
- EELE 447  Mobile Wireless Communications
- EELE 465  Microcontroller Applications
- EELE 481  Optical Design
- EELE 482  Electro-Optical Systems
- EELE 484  Laser Engineering
- EGEN 310R  Multidisciplinary Engineering Design
- EGEN 365  Introduction to Mechatronics
- EGEN 415  Advanced Mechanics of Solids
- EIND 371  Introduction to Computer Integrated Manufacturing
- EIND 413  Ergonomics & Human Factors Engineering
- EIND 422  Introduction to Simulation
- EIND 434  Project Management for Engineers
- EIND 477  Quality Management Systems
- EMEC 403  CAE IV--Design Integration
- EMEC 462  System Dynamics and Control
- EMEC 466  Acoustics, Engineering and the Environment
- EMEC 467  Micro-Electromechanical Systems
- ETME 410  Computerized Numerical Control and Computer-aided Manufacturing Technology
- ETME 415  Design for Manufacturing and Tooling
- ETME 462  Industrial Processing Automation and Controls
- PHSX 427  Advanced Optics
- PHSX 435  Astrophysics
- PHSX 437  Laser Applications

### Total Credits

31
Acceptable substitute is defined as meeting the pre-requisites for the specific course in Aerospace Minor courses listed above, or as allowed by the instructor as an acceptable pre-requisite for the given Aerospace Minor course.

Notes: The following constraints will be imposed on Aerospace Minor Courses:

- **IF A COURSE (or redundant equivalent) IS A SPECIFICALLY REQUIRED COURSE FOR THE STUDENT'S MAJOR DEGREE PROGRAM, IT WILL NOT BE ACCEPTED AS AN AEROSPACE MINOR ELECTIVE.**

- Additional Clarification: Elective courses in a student’s major degree program are not considered as required courses and can, therefore, be used as Aerospace Minor electives. Pre-requisites for courses will be enforced.

- An appeal to include additional classes for the Aerospace Minor can be made if the student/instructor can make a cogent argument as to how the course is relevant to aerospace. That includes relevant 5xx-level and 6xx-level classes.

- All academic policies relevant to MSU are in effect for the Aerospace minor; in particular, all courses used to fulfill the minor must have a grade of C- or better.