Aerospace Engineering, Ph.D.

Curriculum in Doctor of Philosophy – Aerospace Engineering

A candidate for the Ph.D. degree with a major in aerospace engineering must comply with the rules and regulations as outlined in the WVU Graduate Catalog and the specific requirements of the Statler College and the Department of Mechanical, Materials, and Aerospace Engineering (MMAE).

Program Requirements

The doctor of philosophy degree with a major in aerospace engineering is administered through the college’s interdisciplinary Ph.D. program. The research work for the doctoral dissertation must show a high degree of originality on the part of the student and must constitute an original contribution to the art and science of aerospace engineering.

All Ph.D. degree candidates are required to perform research and follow a planned program of study. The student’s research advisor, in conjunction with the student’s Advising and Examining Committee (AEC) will be responsible for determining the plan of study appropriate to the student’s needs. The underlying principle of the planned program is to provide the students with the necessary support to complete their degree and prepare them for their career.

The doctoral courses of study are selected to fit the particular interests and objectives of the student, with proper attention given to broadening related areas of study. The research work for the doctoral dissertation may entail a fundamental investigation into a specialized area or a broad and comprehensive study in a related subject.

All students pursuing a Ph.D. degree in the MMAE department are expected to engage in research and complete and successfully defend a Ph.D. dissertation. They should identify a subject for their Ph.D. dissertation, form a five-member advisory and examining committee, and file a plan of study by the end of their first semester of enrollment in the graduate program. At least one member of the graduate faculty from outside the department is required to serve on the advisory and examining committee.

PUBLICATION REQUIREMENT

Prior to scheduling the dissertation defense, Ph.D. students are required to provide written documentation that they have received formal proof of submission of either:

a.) At least one manuscript, generally co-authored with their research supervisor and about some portion of their PhD dissertation research, to an archival journal for publication, or

b.) At least one patent disclosure, also generally about some portion of their PhD dissertation research.

Curriculum Requirements (BS-PhD Pathway)

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Hours</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>A minimum cumulative GPA of 3.0 is required in all courses.</td>
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</table>

Course Requirements *

Core Area Courses

Select nine (9) hours from one of the following core areas:

Area A: Fluid Mechanics and Aerodynamics (FMA)
- MAE 532 Dynamics of Viscous Fluids
- MAE 624 Convection Heat Transfer
- MAE 636 Fundamentals of Turbulent Flow

Area B: Thermal Sciences and Systems (TSS)
- MAE 521 Advanced Thermodynamics 1
- MAE 532 Dynamics of Viscous Fluids
- MAE 624 Convection Heat Transfer

Area C: Dynamics and Controls (D&C)
- MAE 642 Intermediate Dynamics
- MAE 653 Advanced Vibrations
- MAE 660 Feedback Control in Mechanical Engineering

Area D: Solid Mechanics and Design (SMD)
- MAE 543 Advanced Mechanics of Materials
- MAE 640 Continuum Mechanics
- MAE 642 Intermediate Dynamics
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>MAE 653</td>
<td>Advanced Vibrations</td>
</tr>
<tr>
<td>Area E: Materials Science (MS)</td>
<td></td>
</tr>
<tr>
<td>MAE 580</td>
<td>Crystallography and Crystals</td>
</tr>
<tr>
<td>MAE 583</td>
<td>Thermodynamics and Kinetics of Materials</td>
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<tr>
<td>MAE 649</td>
<td>Microscopy of Materials</td>
</tr>
</tbody>
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**Mathematics Requirements**

Select twelve (12) hours from the following (at least two (2) courses with MATH prefix or MAE 515):

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>MATH 521</td>
<td>Numerical Analysis</td>
</tr>
<tr>
<td>MATH 522</td>
<td>Numerical Solution of PDE</td>
</tr>
<tr>
<td>MATH 541</td>
<td>Modern Algebra 1</td>
</tr>
<tr>
<td>MATH 543</td>
<td>Linear Algebra</td>
</tr>
<tr>
<td>MATH 545</td>
<td>Number Theory 1</td>
</tr>
<tr>
<td>MATH 551</td>
<td>Real Variables 1</td>
</tr>
<tr>
<td>MATH 555</td>
<td>Complex Variables 1</td>
</tr>
<tr>
<td>MATH 560</td>
<td>Introduction to Dynamical Systems and Applications</td>
</tr>
<tr>
<td>MATH 563</td>
<td>Mathematical Modeling</td>
</tr>
<tr>
<td>MATH 564</td>
<td>Intermediate Differential Equations</td>
</tr>
<tr>
<td>MATH 566</td>
<td>Intermediate Partial Differential Equations</td>
</tr>
<tr>
<td>MATH 567</td>
<td>Advanced Calculus 1</td>
</tr>
<tr>
<td>MATH 568</td>
<td>Advanced Calculus</td>
</tr>
<tr>
<td>MATH 573</td>
<td>Graph Theory</td>
</tr>
<tr>
<td>STAT 513</td>
<td>Design of Experiments</td>
</tr>
<tr>
<td>STAT 545</td>
<td>Applied Regression Analysis</td>
</tr>
<tr>
<td>STAT 561</td>
<td>Theory of Probability and Statistics 1</td>
</tr>
<tr>
<td>STAT 562</td>
<td>Theory of Probability and Statistics 2</td>
</tr>
<tr>
<td>MAE 515</td>
<td>Analytical Methods in Engineering</td>
</tr>
<tr>
<td>MAE 623</td>
<td>Conduction Heat Transfer</td>
</tr>
<tr>
<td>MAE 633</td>
<td>Computational Fluid Dynamics</td>
</tr>
<tr>
<td>MAE 640</td>
<td>Continuum Mechanics</td>
</tr>
<tr>
<td>MAE 645</td>
<td>Energy Methods in Applied Mechanics</td>
</tr>
<tr>
<td>CHE 531</td>
<td>Mathematical Methods in Chemical Engineering</td>
</tr>
<tr>
<td>EE 515</td>
<td>Linear Control Systems</td>
</tr>
<tr>
<td>EE 517</td>
<td>Optimal Control</td>
</tr>
<tr>
<td>IENG 518</td>
<td>Technology Forecasting</td>
</tr>
<tr>
<td>IENG 553</td>
<td>Applied Linear Programming</td>
</tr>
<tr>
<td>PHYS 611</td>
<td>Introduction to Mathematical Physics</td>
</tr>
</tbody>
</table>

**Additional Courses**

Select fifteen (15) hours from the following

- Any BIOM, BMEG, CE, CHE, CHEM, CPE, CS, EE, IENG, IH&S, MAE, MATH, MINE, PNGE, PHYS, SAFM, SENG, EXPH 583, or STAT courses 500-795, as approved by the student’s AEC.

**Research**

MAE 797  Research

**Milestones**

- Plan of Study
- Qualifying Exam
- Candidacy Exam
- Publication Requirement
- Final Exam
- Dissertation

**Total Hours** 60
Students who do not hold a baccalaureate degree in aerospace engineering are required to take a set of undergraduate aerospace courses above and beyond the minimum coursework requirements.

No more than 6 hours of independent study can count. No courses below 500 level can count.

Curriculum Requirements (MS-PhD Pathway)

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Course Requirements

**Core Area Courses**

Select one course in the relevant core area from the following:

**Area A: Fluid Mechanics and Aerodynamics (FMA)**
- MAE 532 Dynamics of Viscous Fluids
- MAE 624 Convection Heat Transfer
- MAE 636 Fundamentals of Turbulent Flow

**Area B: Thermal Sciences and Systems (TSS)**
- MAE 521 Advanced Thermodynamics 1
- MAE 532 Dynamics of Viscous Fluids
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**Area C: Dynamics and Controls (D&C)**
- MAE 642 Intermediate Dynamics
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**Area D: Solid Mechanics and Design (SMD)**
- MAE 543 Advanced Mechanics of Materials
- MAE 640 Continuum Mechanics
- MAE 642 Intermediate Dynamics
- MAE 653 Advanced Vibrations

**Area E: Materials Science (MS)**
- MAE 580 Crystallography and Crystals
- MAE 583 Thermodynamics and Kinetics of Materials
- MAE 649 Microscopy of Materials

**Mathematics Requirements**

Select two of the following (at least one course with MATH prefix or MAE 515):

- MATH 521 Numerical Analysis
- MATH 522 Numerical Solution of PDE
- MATH 541 Modern Algebra 1
- MATH 543 Linear Algebra
- MATH 545 Number Theory 1
- MATH 551 Real Variables 1
- MATH 555 Complex Variables 1
- MATH 560 Introduction to Dynamical Systems and Applications
- MATH 563 Mathematical Modeling
- MATH 564 Intermediate Differential Equations
- MATH 566 Intermediate Partial Differential Equations
- MATH 567 Advanced Calculus 1
- MATH 568 Advanced Calculus
- MATH 573 Graph Theory
- STAT 513 Design of Experiments
- STAT 545 Applied Regression Analysis
- STAT 561 Theory of Probability and Statistics 1
**JOURNAL PAPER PUBLICATION REQUIREMENT FOR ALL PHD STUDENTS:**

Beginning with all PhD students admitted for the summer or fall of 2016 and thereafter, every Ph.D. student, prior to his/her dissertation defense, will be required to provide written documentation that they have received formal proof of submission of either:

a.) At least one manuscript, generally co-authored with their research supervisor and about some portion of their PhD dissertation research, to an archival journal for publication, or

b.) At least one patent disclosure, also generally about some portion of their PhD dissertation research.

This publication requirement will have to be satisfied prior to scheduling the defense of the Ph.D. Dissertation.

**Major Learning Outcomes**

**AEROSPACE ENGINEERING**

The MMAE Department is committed to deliver high quality education and research experience to all graduate students in order to enable them to achieve success in their careers, though the following Learning Goals:

- Expertise, depth and breadth in a chosen field of aerospace engineering.
- Capacity to engage in original research, advanced technological discovery and innovation in order to advance the frontiers of knowledge in the science of the aerospace engineering discipline.
- Capacity of effective high level communication in order to document, disseminate and transfer knowledge of the science of the aerospace engineering discipline in educational, research or applied workplace settings.
- Appreciation and understanding of the role of the science of the aerospace engineering discipline in a global and societal context.