

# ADDITIVE MANUFACTURING AND DESIGN

<b>Graduate Program Head</b>	Allison Beese
<b>Program Code</b>	AMD
<b>Campus(es)</b>	University Park (M.S.) World Campus (M.Eng.)
<b>Degrees Conferred</b>	Master of Science (M.S.) Master of Engineering (M.Eng.)
<b>The Graduate Faculty</b>	View ( <a href="https://secure.gradsch.psu.edu/gpms/?searchType=fac&amp;prog=AMD">https://secure.gradsch.psu.edu/gpms/?searchType=fac&amp;prog=AMD</a> )

The overall goal of the Master of Science in Additive Manufacturing and Design and Master of Engineering in Additive Manufacturing and Design is to educate students and working engineers to become technically outstanding experts in additive manufacturing. Specifically, the objectives include:

1. Apply foundational knowledge, critical thinking, problem solving, and creativity in the uses of additive manufacturing and associated design tools and methods.
2. Grow as leaders in manufacturing while maintaining the highest ethical standards in applying additive manufacturing to industry-relevant problems and design challenges.
3. Strive for the advancement of the state-of-art in additive manufacturing and design.
4. Develop innovative solutions through new design paradigms in their respective industries.

## Admission Requirements

Applicants apply for admission to the program via the Graduate School application for admission (<https://gradschool.psu.edu/graduate-admissions/how-to-apply/>). Requirements listed here are in addition to Graduate Council policies listed under GCAC-300 Admissions Policies (<https://gradschool.psu.edu/graduate-education-policies/>).

The language of instruction at Penn State is English. English proficiency test scores (TOEFL/IELTS) may be required for international applicants. See GCAC-305 Admission Requirements for International Students (<https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-300/gcac-305-admission-requirements-international-students/>) for more information.

To maintain a high quality program, it is important that our students are of a caliber to succeed. As such, the admission requirements for the students enrolling in the M.S. and M.Eng. degree program will be based on: academic records, applicable work experience, their personal statement of interests in additive manufacturing design, and three letters of recommendation from a previous professor or supervisor who can attest to the applicant's academic potential. Applicants will be expected to have a Bachelor of Science or four-year Associates degree in engineering, manufacturing, materials science, or related field from a U.S. regionally accredited institution or from an officially recognized degree-granting international institution. An undergraduate cumulative grade point average of 3.0 or better on a 4.0 scale in the final two years

of undergraduate studies is required. Official GRE scores are not required but will be considered if submitted.

## Degree Requirements

### Master of Engineering (M.Eng.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-700 Professional Degree Policies (<https://gradschool.psu.edu/graduate-education-policies/>).

A minimum of 30 credits at the 400, 500, or 800 level is required. At least 18 credits must be at the 500 or 800 level, with a minimum of 6 credits at the 500 level.

Code	Title	Credits
<b>Required Courses</b>		
Complete the following 5 required courses that total 19 credits with a 19 grade point average of 3.00 or higher:		
EDSGN 562	Design for Additive Manufacturing	
ESC 545	Engineering and Scientific Principles of Additive Manufacturing	
IE 527	Additive Manufacturing Processes	
MATSE 567	Additive Manufacturing of Metallic Materials	
ME 566	Metal Additive Manufacturing Laboratory	
Complete a minimum of 8 credits of electives in 400 and/or 500 level courses. A listing of approved courses is maintained by the program. <sup>1</sup>		8
Complete one credit of colloquium preferably in the first two semesters in the program. The following courses are offered to meet this requirement: <sup>3</sup>		
EDSGN 590	Colloquium	
ESC 514	Engineering Science and Mechanics Seminar	
IE 590	I E Colloquium	
MATSE 590	Colloquium	
ME 590	Colloquium	
Complete SARI (Scholarship and Research Integrity) training		
<b>Culminating Experience</b>		
A scholarly paper must be completed to meet the specific requirement of the culminating experience. This paper will demonstrate depth of knowledge to his/her adviser, a second reader, and the Director of the AMD Graduate Program.		
AMD 596	Individual Studies (Scholarly Paper) <sup>2</sup>	3
<b>Total Credits</b>		<b>30</b>

<sup>1</sup> Note that AMD 596 cannot be used to fulfill this requirement.

<sup>2</sup> M.Eng. students can complete a three (3) credit course in one (1) semester.

<sup>3</sup> The one-credit colloquium does not count toward the 30 graduate course credits required.

### Culminating Experience

Candidates must write a culminating project paper on a topic mutually agreed upon with the adviser. Students will be encouraged to utilize their current employer to identify a relevant or practical problem of importance that additive manufacturing and appropriate design methods could address. The quality of the required paper is such that it must be suitable for publication in a professional journal or proceedings at a national or international conference, which generally requires a peer-review process.

## Master of Science (M.S.)

Requirements listed here are in addition to Graduate Council policies listed under GCAC-600 Research Degree Policies. (<https://gradschool.psu.edu/graduate-education-policies/>)

A minimum of 30 credits at the 400, 500, 600, or 800 level is required. At least 18 credits must be in 500-level courses.

Code	Title	Credits
<b>Required Courses</b>		
Complete the following 5 required courses that total 19 credits with a 19 grade point average of 3.00 or higher.		
EDSGN 562	Design for Additive Manufacturing	
ESC 545	Engineering and Scientific Principles of Additive Manufacturing	
IE 527	Additive Manufacturing Processes	
MATSE 567	Additive Manufacturing of Metallic Materials	
ME 566	Metal Additive Manufacturing Laboratory	
Complete a minimum of 8 credits of electives in 400 and/or 500 level courses. A listing of approved courses is maintained by the program. <sup>1</sup>		8
Complete one credit of colloquium preferably in the first two semesters in the program. The following courses are offered to meet this requirement. <sup>3</sup>		
EDSGN 590	Colloquium	
ESC 514	Engineering Science and Mechanics Seminar	
IE 590	I E Colloquium	
MATSE 590	Colloquium	
ME 590	Colloquium	
Complete SARI (Scholarship and Research Integrity) training		
<b>Culminating Experience</b>		
A scholarly paper or thesis must be completed to meet the specific requirement of the culminating experience. The paper or thesis will demonstrate depth of knowledge to his/her adviser, a second reader, and the Director of the AMD Graduate Program.		
AMD 596 or AMD 600	Individual Studies (Scholarly Paper) Thesis Research	3-6
<b>Total Credits</b>		<b>30-33</b>

<sup>1</sup> Note that AMD 596 cannot be used to fulfill this requirement.

<sup>2</sup> M.S. paper option students are required to complete one (1) credit in each of three (3) semesters.

<sup>3</sup> The one-credit colloquium does not count toward the 30 graduate course credits required.

The M.S. degree scholarly paper option is designed to be completed in 3 semesters, or one calendar year (fall, spring, and summer). A research adviser will be assigned to students in their first semester. Students who need more time to complete the final paper will be allowed to complete the paper, and have it reviewed and approved after the third semester has ended. Students are not required to remain in residence while they complete the final paper. However, extensions granted to students in this program must comply with the Graduate Council policy on deferred grades (<http://gradschool.psu.edu/graduate-education-policies/gcac/gcac-400/grading-system/>). Students who choose the thesis option for their culminating experience are expected to take two years to complete the degree.

## Culminating Experience

Candidates may choose a scholarly paper or thesis option to fulfill their culminating experience. Students who choose the scholarly paper option must write a culminating project paper on a topic mutually agreed upon with the adviser and register for 3 credits of AMD 596 to complete the paper. Students will be encouraged to utilize an industry internship or current employer to identify a relevant or practical problem of importance that additive manufacturing and appropriate design methods could address. The quality of the required paper is such that it must be suitable for publication in a professional journal or proceedings at a national or international conference, which generally requires a peer-review process.

Candidates who choose the thesis option must write and defend, at an oral examination, a thesis based upon original research in the field. The thesis will demonstrate depth of knowledge to his/her adviser, a second reader, and the Director of the AMD Graduate Program. Candidates must submit a thesis following the procedures specified by the Graduate School and register for 6 credits of AMD 600. The thesis must be accepted by the advisers and/or committee members, the head of the graduate program, and the Graduate School, and the student must pass the thesis defense.

## Minor

A graduate minor is available in any approved graduate major or dual-title program. The default requirements for a graduate minor are stated in Graduate Council policies listed under GCAC-600 Research Degree Policies (<https://gradschool.psu.edu/graduate-education-policies/>) and GCAC-700 Professional Degree Policies (<https://gradschool.psu.edu/graduate-education-policies/>), depending on the type of degree the student is pursuing:

- GCAC-611 Minor - Research Doctorate (<https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/gcac-611-minor-research-doctorate/>)
- GCAC-641 Minor - Research Master's (<https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-600/gcac-641-minor-research-masters/>)
- GCAC-709 Minor - Professional Doctorate (<https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-700/gcac-709-professional-doctoral-minor/>)
- GCAC-741 Minor - Professional Master's (<https://gradschool.psu.edu/graduate-education-policies/gcac/gcac-700/gcac-741-masters-minor-professional/>)

## Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the Tuition & Funding (<https://gradschool.psu.edu/graduate-funding/>) section of The Graduate School's website. Students on graduate assistantships must adhere to the course load limits (<https://gradschool.psu.edu/graduate-education-policies/gsad/gsad-900/gsad-901-graduate-assistants/>) set by The Graduate School.

World Campus students in graduate degree programs may be eligible for financial aid. Refer to the Tuition and Financial Aid section (<https://www.worldcampus.psu.edu/tuition-and-financial-aid/>) of the World Campus website for more information.

## Courses

Graduate courses carry numbers from 500 to 699 and 800 to 899. Advanced undergraduate courses numbered between 400 and 499 may

be used to meet some graduate degree requirements when taken by graduate students. Courses below the 400 level may not. A graduate student may register for or audit these courses in order to make up deficiencies or to fill in gaps in previous education but not to meet requirements for an advanced degree.

Additive Manufacturing and Design (AMD) Course List (<https://bulletins.psu.edu/university-course-descriptions/graduate/amd/>)

## Learning Outcomes

### Master of Engineering (M.Eng.)

1. **APPLY/CREATE** - Identify, formulate, and solve a relevant or practical problem of importance that additive manufacturing and design methods can address.
2. **COMMUNICATE** - Demonstrate proficiency in oral and written communication while addressing additive manufacturing and design ideas.
3. **THINK** - Critically analyze primary scientific literature to make sound engineering decisions.
4. **PROFESSIONAL PRACTICE** - Grow as leaders in manufacturing while maintaining the highest ethical standards in applying additive manufacturing to industry-relevant problems.
5. **KNOW** - Demonstrate an understanding of advanced core additive manufacturing principles.

### Master of Science (M.S.)

1. **APPLY/CREATE** - Apply additive manufacturing approaches and frameworks to address relevant engineering challenges.
2. **PROFESSIONAL PRACTICE** - Effectively function in a multidisciplinary team-based environment.
3. **THINK** - Identify, analyze, and synthesize scholarly literature relating to the field of additive manufacturing.
4. **COMMUNICATE** - Articulate the value proposition for additive manufacturing in a given industry.
5. **KNOW** - Demonstrate foundational knowledge, critical thinking, and creativity in the uses of additive manufacturing and associated design methods.

## Contact

<b>Campus</b>	University Park
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<b>Director of Graduate Studies (DGS) or Professor-in-Charge (PIC)</b>	Allison Michelle Beese
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<b>Program Website</b>	View ( <a href="http://AMDprogram.psu.edu">http://AMDprogram.psu.edu</a> )

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<b>Graduate Program Head</b>	Allison Michelle Beese
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<b>Program Website</b>	View ( <a href="http://www.worldcampus.psu.edu/degrees-and-certificates/penn-state-online-additive-manufacturing-and-design-masters-degree/overview/">http://www.worldcampus.psu.edu/degrees-and-certificates/penn-state-online-additive-manufacturing-and-design-masters-degree/overview/</a> )