Advanced Manufacturing

Degrees Offered
- Graduate Certificate in Advanced Manufacturing
- Master of Science in Advanced Manufacturing (Non-Thesis)

Program Description
The interdisciplinary Advanced Manufacturing graduate program will prepare graduates to meet the challenges of careers in advanced manufacturing.

Program Requirements

Graduate Certificate (12 credit hours)

Core Requirements
- AMFG401 ADDITIVE MANUFACTURING 3.0
- AMFG501 ADDITIVE MANUFACTURING

Select 2 of 3 of the Remaining Core Courses:
- AMFG531 MATERIALS FOR ADDITIVE MANUFACTURING 3.0
- AMFG421 DESIGN FOR ADDITIVE MANUFACTURING 3.0
- AMFG511 DATA DRIVEN ADVANCED MANUFACTURING 3.0

Electives
- ELECT Select electives from the Advanced Manufacturing list below

Total Semester Hrs 12.0

Master of Science, Non-Thesis (30 credit hours)

Core Requirements
- AMFG401 ADDITIVE MANUFACTURING 3.0
- AMFG501 ADDITIVE MANUFACTURING

Select 2 of 3 of the Remaining Core Courses:
- AMFG531 MATERIALS FOR ADDITIVE MANUFACTURING 3.0
- AMFG421 DESIGN FOR ADDITIVE MANUFACTURING 3.0
- AMFG511 DATA DRIVEN ADVANCED MANUFACTURING 3.0

Electives
- ELECT Electives As Approved By Advisor

Mines’ Combined Undergraduate / Graduate Degree Program

Students enrolled in Mines’ combined undergraduate/graduate program (with uninterrupted registration from the time the student earns a Mines undergraduate degree to the time the student begins a Mines graduate degree) may double count up to six hours of credits which were used in fulfilling the requirements of their undergraduate degree at Mines, towards their graduate program. Any courses that count towards the graduate degree requirements as either “Required Coursework” or “Elective Coursework”, as defined below, may be used for the purposes of double counting at the discretion of the advisor (MS Non-Thesis) or thesis committee (MS Thesis or Ph.D.). These courses must have been passed with a "B-" or better and meet all other University, Department, Division, and Program requirements for graduate credit.

The Advanced Manufacturing program will be anchored by select signature core courses and will offer a diverse array of electives drawn from an approved list of existing courses within the ME, MME, EE, CS, Physics, Math and Finite Element Analysis departments. Students who choose the MS-NT degree option will choose their electives with the intent of specializing in one of three key areas (or they can choose to diversify across areas):

- Materials
- Design
- Data

Advanced Manufacturing Electives:

Additive Manufacturing of Structural Materials
- MEGN511 FATIGUE AND FRACTURE 3.0
- MEGN515 COMPUTATIONAL MECHANICS 3.0
- MLGN505 MECHANICAL PROPERTIES OF MATERIALS 3.0
- MTGN514 DEFECT CHEMISTRY AND TRANSPORT PROCESSES IN CERAMIC SYSTEMS 3.0
- MTGN557 SOLIDIFICATION 3.0
- MTGN560 ANALYSIS OF METALLURGICAL FAILURES 3.0
- MTGN564 ADVANCED FORGING AND FORMING 3.0
- MTGN565 MECHANICAL PROPERTIES OF CERAMICS AND COMPOSITES 3.0
- MTGN580 ADVANCED WELDING METALLURGY 3.0
- PHGN585 NONLINEAR OPTICS 3.0
- AMFG531 MATERIALS FOR ADDITIVE MANUFACTURING 3.0
- AMFG511 DATA DRIVEN ADVANCED MANUFACTURING 3.0
- AMFG421 DESIGN FOR ADDITIVE MANUFACTURING 3.0
- AMFG521 DESIGN FOR ADDITIVE MANUFACTURING 3.0
- ELECT Electives As Approved By Advisor

Design for Additive Manufacturing
- FEGN525 ADVANCED FEA THEORY & PRACTICE 3.0
- FEGN526 STATIC AND DYNAMIC APPLICATIONS IN FEA 3.0
- FEGN527 NONLINEAR APPLICATIONS IN FEA 3.0
- FEGN528 FEA FOR ADVANCED DESIGN APPLICATIONS 3.0
- AMFG531 MATERIALS FOR ADDITIVE MANUFACTURING 3.0
- AMFG511 DATA DRIVEN ADVANCED MANUFACTURING 3.0
- AMFG421 DESIGN FOR ADDITIVE MANUFACTURING 3.0
- AMFG521 DESIGN FOR ADDITIVE MANUFACTURING 3.0
- ELECT Electives As Approved By Advisor

Data-Driven Materials Manufacturing
- CSCi507 INTRODUCTION TO COMPUTER VISION 3.0
- CSCi508 ADVANCED TOPICS IN PERCEPTION AND COMPUTER VISION 3.0
- CSCi575 MACHINE LEARNING 3.0
- EENG509 SPARSE SIGNAL PROCESSING 3.0
- EENG511 CONVEX OPTIMIZATION AND ITS ENGINEERING APPLICATIONS 3.0
- EENG515 MATHEMATICAL METHODS FOR SIGNALS AND SYSTEMS 3.0
Courses

AMFG501. ADDITIVE MANUFACTURING. 3.0 Semester Hrs.
(II) Additive Manufacturing (AM), also known as 3D Printing in the popular press, is an emerging manufacturing technology that will see widespread adoption across a wide range of industries during your career. Subtractive Manufacturing (SM) technologies (CNCs, drill presses, lathes, etc.) have been an industry mainstay for over 100 years. The transition from SM to AM technologies, the blending of SM and AM technologies, and other developments in the manufacturing world has direct impact on how we design and manufacture products. This course will prepare students for the new design and manufacturing environment that AM is unlocking. The graduate section of this course differs from the undergraduate section in that graduate students perform AM-related research. While students complete quizzes and homework, they do not take a midterm or final exam. Prerequisites: MEGN200 and MEGN201 or equivalent project classes. 3 hours lecture; 3 semester hours.

AMFG511. DATA DRIVEN ADVANCED MANUFACTURING. 3.0 Semester Hrs.
(I) Although focused on materials manufacturing, this course is intended for all students interested in experimental design and data informatics. It will include both directed assignments to reinforce the concepts and algorithms discussed in class and a term project that will encourage students to apply these concepts to a problem of their choosing. Some programming background would be beneficial but is not necessary; the basics of python and the sklearn machine learning toolkit will be covered in the first weeks of the course. 3 hours lecture; 3 semester hours.

AMFG521. DESIGN FOR ADDITIVE MANUFACTURING. 3.0 Semester Hrs.
(II) Design for Additive Manufacturing (DAM) introduces common considerations that must be addressed to successfully design or re-design parts for additive manufacturing methods. Industry-leading hardware and FEA software will be used to explore all phases of the DAM workflow, including topology optimization, additive process simulation, distortion compensation, and in-service performance. 3 hours lecture; 3 semester hours.

AMFG531. MATERIALS FOR ADDITIVE MANUFACTURING. 3.0 Semester Hrs.
(II) This course will cover various structural materials used in additive manufacturing (AM) processes. Focus will be on polymer, ceramic, and metallic compositions. General chemistry of each material will be covered with additional focus on the behavior of these materials when processed using AM. The course will span the entire AM lifecycle from feedstock fabrication to fabrication by AM to post processing and inspection of as-fabricated material. Students will have hands-on exposure to AM processes and will conduct laboratory studies of AM material properties. Additionally, students will conduct a semester-long research project exploring some aspect of AM materials. 3 hours lecture; 3 semester hours.

AMFG598. SPECIAL TOPICS IN ADVANCED MANUFACTURING. 1-6 Semester Hr.
(I, II) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once. Prerequisite: none. Variable credit; 1 to 6 credit hours. Repeatable for credit under different titles.