

MECHANICAL ENGINEERING & APPLIED MECHANICS, MSE

The master's in Mechanical Engineering and Applied Mechanics (MEAM) is innovative, unique, and nationally recognized for its excellence. We are at the forefront in preparing students for leadership careers by providing opportunities to work in emerging and interdisciplinary areas that are fueling exciting advances in technology. The program can be tailored and customized to meet individual needs under the guidance and approval of an academic advisor. Students can choose to concentrate in *Mechatronic and Robotic Systems, *Micro/Nano Systems, *Heat Transfer, Fluid Mechanics, and Energy, *Mechanics of Materials and *Design and Manufacturing.

For more information: <http://www.me.upenn.edu/prospective-students/masters/masters-degrees.php>

Curriculum

10 course units are required for the MSE MEAM degree.

Code	Title	Course Units
Engineering Math		
Select 2 Engineering Math options from the following:		2
ENM 5020	Numerical Methods and Modeling	
ENM 5030	Introduction to Probability and Statistics	
ENM 5100	Foundations of Engineering Mathematics - I	
ENM 5110	Foundations of Engineering Mathematics - II	
ENM 5120	Nonlinear Dynamics and Chaos	
ENM 5310	Data-driven Modeling and Probabilistic Scientific Computing	
ENM 5400	Topics In Computational Science and Engineering	
CIS 5200	Machine Learning	
MEAM 5270	Finite Element Analysis	
Concentration Core ¹		
Select 1 Required Core course		1
Select 2 Concentration electives		2
Select 2 Concentration Breadth electives		2
Electives		
Select 3 Electives ²		3
Seminar Requirement		
2 Semesters of MEAM Seminar		
Total Course Units		10

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There is one required course for each concentration area. In addition to the one required course for each concentration area, two additional courses must be selected from the preapproved core requirement list for the student's chosen concentration (Appendix A of the handbook). The remaining two MEAM courses can be any MEAM graduate courses selected by the student in consultation with their advisor.

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A complete list of pre-approved electives can be found in the MEAM MSE Student Handbook. Approval is required if a student wishes to take a graduate course not listed in the handbook.

Mechatronic and Robotic Systems

Code	Title	Course Units
Concentration Core		
MEAM 5100	Design of Mechatronic Systems	
Select 2 course units:		
MEAM 5130	Feedback Control Design and Analysis	
MEAM 5160	Advanced Mechatronic Reactive Spaces.	
MEAM 5170	Control and Optimization with Applications in Robotics	
MEAM 5200	Introduction to Robotics	
MEAM 5230	Control Systems for Robotics	
MEAM 5350	Advanced Dynamics	
MEAM 5430	Performance, Stability and Control of UAVs	
MEAM 5500	Design of Microelectromechanical Systems	
MEAM 6130	Non-Linear Control Theory	
MEAM 6200	Advanced Robotics	
MEAM 6920	Topics in Mechanical Systems	
Select 2 more MEAM graduate courses, level 5000 and above.		
Electives		
Select 3 Electives:		
EAS 5070	Intellectual Property and Business Law for Engineers	
EAS 5450	Engineering Entrepreneurship I	
EAS 5120	Engineering Negotiation	
EAS 5460	Engineering Entrepreneurship II	
EAS 5950	Foundations of Leadership	
ESE 5000	Linear Systems Theory	
ESE 5040	Intro to Linear, Nonlinear and Integer Optimization	
ESE 5190	Introduction to Embedded Systems	
ESE 5310	Digital Signal Processing	
ESE 5400	Engineering Economics	
ESE 5430	Human Systems Engineering	
ESE 6500	Learning in Robotics	
CIS 5200	Machine Learning	
CIS 5210	Artificial Intelligence	
CIS 5400	Principles of Embedded Computation	
CIS 5800	Machine Perception	
CIS 5810	Computer Vision & Computational Photography	
CIT 5900	Programming Languages and Techniques	
IPD 5010	Integrated Computer-Aided Design, Manufacturing and Analysis	

Micro/Nano Systems

Code	Title	Course Units
Concentration Core		
MEAM 5370	Nanotribology	
MEAM 5500	Design of Microelectromechanical Systems	
MEAM 5050	Mechanical Properties of Macro/Nanoscale Materials	
MEAM 5070	Fundamentals of Materials	
MEAM 5190	Elasticity and Micromechanics of Materials	
MEAM 5270	Finite Element Analysis	
MEAM 5370	Nanotribology	
MEAM 5500	Design of Microelectromechanical Systems	
MEAM 5530	Atomic Modeling in Materials Science	
MEAM 5550	Nanoscale Systems Biology	
MEAM 5640	The Principles and Practice of Microfabrication Technology	
MEAM 5750	Micro and Nano Fluidics	
MEAM 5800	Electrochemistry for Energy, Nanofabrication and Sensing	
Select 2 more MEAM graduate courses, level 5000 and above.		

Electives

Select 3 Electives:

EAS 5070	Intellectual Property and Business Law for Engineers	
EAS 5120	Engineering Negotiation	
EAS 5450	Engineering Entrepreneurship I	
EAS 5460	Engineering Entrepreneurship II	
EAS 5950	Foundations of Leadership	
ESE 5210	The Physics of Solid State Energy Devices	
ESE 5360	Nanofabrication and Nanocharacterization	
MSE 5200	Structure of Materials	
MSE 5250	Nanoscale Science and Engineering	
MSE 5650	Fabrication and Characterization of Micro and Nanostructured Materials	

Heat Transfer, Fluid Mechanics, and Energy Science and Engineering

Code	Title	Course Units
Concentration Core		
MEAM 5360	Viscous Fluid Flow and Modern Applications	
	or MEAM 5700 Transport Processes I	
Select 2 course units in:		
MEAM 5020	Energy Engineering in Power Plants and Transportation Systems	
MEAM 5030	Direct Energy Conversion: from Macro to Nano	
MEAM 5040	Tribology	
MEAM 5270	Finite Element Analysis	
MEAM 5300	Continuum Mechanics	

MEAM 5360	Viscous Fluid Flow and Modern Applications	
MEAM 5380	Turbulence	
MEAM 5450	Aerodynamics	
MEAM 5610	Thermodynamics: Foundations, Energy, Materials	
MEAM 5700	Transport Processes I	
MEAM 5710	Advanced Topics in Transport Phenomena	
MEAM 5750	Micro and Nano Fluidics	
MEAM 5800	Electrochemistry for Energy, Nanofabrication and Sensing	
MEAM 6420	Advanced Fluid Mechanics	
MEAM 6460	Computational Mechanics	
MEAM 6620	Advanced Molecular Thermodynamics	
MSE 5250	Nanoscale Science and Engineering	
Select 2 more MEAM graduate courses, level 500 and above.		
Electives		
Select 3 Electives:		
CBE 5450	Electrochemical Energy Conversion and Storage	
CBE 5460	Fundamentals of Industrial Catalytic Processes	
CBE 6180	Advanced Molecular Thermodynamics	
CBE 6400	Transport Processes I	
CBE 6410	Transport Processes II (Nanoscale Transport)	
EAS 5010	Energy and its Impacts: Technology, Environment, Economics, Sustainability.	
EAS 5020	Renewable Energy and Its Impacts: Technology, Environment, Economics, Sustainability.	
EAS 5070	Intellectual Property and Business Law for Engineers	
EAS 5120	Engineering Negotiation	
EAS 5450	Engineering Entrepreneurship I	
EAS 5460	Engineering Entrepreneurship II	
EAS 5950	Foundations of Leadership	
ENGR 5030	Engineering in Oil, Gas and Coal, from Production to End Use	
MSE 5450	Materials for Energy and Environmental Sustainability	
MSE 5550	Electrochemical Engineering of Materials	

Mechanics of Materials

Code	Title	Course Units
Concentration Core		
MEAM 5190	Elasticity and Micromechanics of Materials	1
Select 2 course units in:		
MEAM 5040	Tribology	
MEAM 5050	Mechanical Properties of Macro/Nanoscale Materials	
MEAM 5070	Fundamentals of Materials	
MEAM 5080	Materials and Manufacturing for Mechanical Design	

MEAM 5270	Finite Element Analysis
MEAM 5300	Continuum Mechanics
MEAM 5370	Nanotribology
MEAM 5530	Atomic Modeling in Materials Science
MEAM 5500	Design of Microelectromechanical Systems
MEAM 5640	The Principles and Practice of Microfabrication Technology
MEAM 5700	Transport Processes I
MEAM 6320	Plasticity
MEAM 6330	Mechanics of Adhesion and Fracture
MEAM 6340	Rods and Shells
MEAM 6350	Composite Materials
MEAM 6630	Mechanics of Macromolecules
Select 2 more MEAM graduate courses, level 5000 and above.	

Electives

Select 3 Electives:	3
EAS 5070	Intellectual Property and Business Law for Engineers
EAS 5120	Engineering Negotiation
EAS 5450	Engineering Entrepreneurship I
EAS 5460	Engineering Entrepreneurship II
EAS 5950	Foundations of Leadership

Design and Manufacturing

Code	Title	Course Units
Concentration Core		
MEAM 5140	Design for Manufacturability	1
Select 2 course units in:		2
MEAM 5040	Tribology	
MEAM 5080	Materials and Manufacturing for Mechanical Design	
MEAM 5100	Design of Mechatronic Systems	
MEAM 5160	Advanced Mechatronic Reactive Spaces.	
MEAM 5270	Finite Element Analysis	
MEAM 5370	Nanotribology	
MEAM 5430	Performance, Stability and Control of UAVs	
MEAM 5500	Design of Microelectromechanical Systems	
MEAM 5640	The Principles and Practice of Microfabrication Technology	
Select 2 more MEAM graduate courses, level 5000 and above.		2
Electives		
Select 3 Electives:		3
ARCH 7260	Furniture Design Strategic Process	
CIS 5600	Interactive Computer Graphics	
EAS 5070	Intellectual Property and Business Law for Engineers	
EAS 5120	Engineering Negotiation	
EAS 5450	Engineering Entrepreneurship I	
EAS 5460	Engineering Entrepreneurship II	
EAS 5950	Foundations of Leadership	
IPD 5010	Integrated Computer-Aided Design, Manufacturing and Analysis	

IPD 5040	Rehab Engineering and Design
IPD 5090	Needfinding
IPD 5110	How to Make Things: Production Prototyping Studio
IPD 5150	Product Design
IPD 5250	Ergonomics/Human Factors Based Product Design
IPD 5270	Industrial Design I

The degree and major requirements displayed are intended as a guide for students entering in the Fall of 2022 and later. Students should consult with their academic program regarding final certifications and requirements for graduation.
