

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 502	Numerical Methods and Modeling	
ENM 503	Introduction to Probability and Statistics	
ENM 510	Foundations of Engineering Mathematics - I	
ENM 511	Foundations of Engineering Mathematics - II	
ENM 512	Nonlinear Dynamics and Chaos	
ENM 531	Data-driven Modeling and Probabilistic Scientific Computing	
ENM 540	Topics In Computational Science and Engineering	
CIS 520	Machine Learning	
MEAM 527	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

¹ 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.

² 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 510	Design of Mechatronic Systems	
Select 2 course units:		
MEAM 513	Feedback Control Design and Analysis	
MEAM 516	Advanced Mechatronic Reactive Spaces.	
MEAM 517	Control and Optimization with Applications in Robotics	
MEAM 520	Introduction to Robotics	
MEAM 523	Control Systems for Robotics	
MEAM 535	Advanced Dynamics	
MEAM 543	Performance, Stability and Control of UAVs	
MEAM 550	Design of Microelectromechanical Systems	
MEAM 613	Non-Linear Control Theory	
MEAM 620	Advanced Robotics	
MEAM 692	Topics in Mechanical Systems	
Select 2 more MEAM graduate courses, level 500 and above.		
Electives		
Select 3 Electives:		
EAS 507	Intellectual Property and Business Law for Engineers	
EAS 545	Engineering Entrepreneurship I	
EAS 512	Engineering Negotiation	
EAS 546	Engineering Entrepreneurship II	
EAS 595	Foundations of Leadership	
ESE 500	Linear Systems Theory	
ESE 504	Intro to Linear, Nonlinear and Integer Optimization	
ESE 519	Real-Time Embedded Systems	
ESE 531	Digital Signal Processing	
ESE 540	Engineering Economics	
ESE 543	Human Systems Engineering	
ESE 650	Learning in Robotics	
CIS 520	Machine Learning	
CIS 521	Artificial Intelligence	
CIS 540	Principles of Embedded Computation	
CIS 580	Machine Perception	
CIS 581	Computer Vision & Computational Photography	
CIT 590	Programming Languages and Techniques	
IPD 501	Integrated Computer-Aided Design, Manufacturing and Analysis	

Micro/Nano Systems

Code	Title	Course Units
Concentration Core		
MEAM 537	Nanotribology	

MEAM 550	Design of Microelectromechanical Systems
MEAM 505	Mechanical Properties of Macro/Nanoscale Materials
MEAM 507	Fundamentals of Materials
MEAM 519	Elasticity and Micromechanics of Materials
MEAM 527	Finite Element Analysis
MEAM 537	Nanotribology
MEAM 550	Design of Microelectromechanical Systems
MEAM 553	Atomic Modeling in Materials Science
MEAM 555	Nanoscale Systems Biology
MEAM 564	The Principles and Practice of Microfabrication Technology
MEAM 575	Micro and Nano Fluidics
MEAM 580	Electrochemistry for Energy, Nanofabrication and Sensing
Select 2 more MEAM graduate courses, level 500 and above.	
Electives	
Select 3 Electives:	
EAS 507	Intellectual Property and Business Law for Engineers
EAS 512	Engineering Negotiation
EAS 545	Engineering Entrepreneurship I
EAS 546	Engineering Entrepreneurship II
EAS 595	Foundations of Leadership
ESE 521	The Physics of Solid State Energy Devices
ESE 536	Nanofabrication and Nanocharacterization
MSE 520	Structure of Materials
MSE 525	Nanoscale Science and Engineering
MSE 565	Fabrication and Characterization of Micro and Nanostructured Materials

Heat Transfer, Fluid Mechanics, and Energy Science and Engineering

Code	Title	Course Units
------	-------	--------------

Concentration Core

MEAM 536	Viscous Fluid Flow and Modern Applications	
	or MEAM 571 Transport Processes I	

Select 2 course units in:

MEAM 502	Energy Engineering in Power Plants and Transportation Systems
MEAM 503	Direct Energy Conversion: from Macro to Nano
MEAM 504	Tribology
MEAM 527	Finite Element Analysis
MEAM 530	Continuum Mechanics
MEAM 536	Viscous Fluid Flow and Modern Applications
MEAM 538	Turbulence
MEAM 545	Aerodynamics
MEAM 561	Thermodynamics: Foundations, Energy, Materials

MEAM 570	Transport Processes I
MEAM 571	Advanced Topics in Transport Phenomena
MEAM 575	Micro and Nano Fluidics
MEAM 580	Electrochemistry for Energy, Nanofabrication and Sensing
MEAM 642	Advanced Fluid Mechanics
MEAM 646	Computational Mechanics
MEAM 647	
MEAM 662	Advanced Molecular Thermodynamics
MSE 525	Nanoscale Science and Engineering
Select 2 more MEAM graduate courses, level 500 and above.	
Electives	
Select 3 Electives:	
CBE 545	Electrochemical Energy Conversion and Storage
CBE 546	Fundamentals of Industrial Catalytic Processes
CBE 617	
CBE 618	Advanced Molecular Thermodynamics
CBE 640	Transport Processes I
CBE 641	Transport Processes II (Nanoscale Transport)
EAS 501	Energy and its Impacts: Technology, Environment, Economics, Sustainability.
EAS 502	Renewable Energy and Its Impacts: Technology, Environment, Economics, Sustainability.
EAS 507	Intellectual Property and Business Law for Engineers
EAS 512	Engineering Negotiation
EAS 545	Engineering Entrepreneurship I
EAS 546	Engineering Entrepreneurship II
EAS 595	Foundations of Leadership
ENGR 503	Engineering in Oil, Gas and Coal, from Production to End Use
MSE 545	Materials for Energy and Environmental Sustainability
MSE 555	Electrochemical Engineering of Materials

Mechanics of Materials

Code	Title	Course Units
------	-------	--------------

Concentration Core

MEAM 519	Elasticity and Micromechanics of Materials	1
----------	--	---

Select 2 course units in:

MEAM 504	Tribology	
MEAM 505	Mechanical Properties of Macro/Nanoscale Materials	
MEAM 507	Fundamentals of Materials	
MEAM 508	Materials and Manufacturing for Mechanical Design	
MEAM 527	Finite Element Analysis	
MEAM 530	Continuum Mechanics	
MEAM 537	Nanotribology	

MEAM 553	Atomic Modeling in Materials Science
MEAM 554	
MEAM 555	Nanoscale Systems Biology
MEAM 632	Plasticity
MEAM 633	Mechanics of Adhesion and Fracture
MEAM 634	Rods and Shells
MEAM 635	Composite Materials
MEAM 663	Mechanics of Macromolecules

Select 2 more MEAM graduate courses, level 500 and above.

Electives

Select 3 Electives: 3

EAS 507	Intellectual Property and Business Law for Engineers
EAS 512	Engineering Negotiation
EAS 545	Engineering Entrepreneurship I
EAS 546	Engineering Entrepreneurship II
EAS 595	Foundations of Leadership

Design and Manufacturing

Code	Title	Course Units
------	-------	--------------

Concentration Core

MEAM 514	Design for Manufacturability	1
----------	------------------------------	---

Select 2 course units in: 2

MEAM 504	Tribology
MEAM 508	Materials and Manufacturing for Mechanical Design
MEAM 510	Design of Mechatronic Systems
MEAM 516	Advanced Mechatronic Reactive Spaces.
MEAM 527	Finite Element Analysis
MEAM 537	Nanotribology
MEAM 543	Performance, Stability and Control of UAVs
MEAM 550	Design of Microelectromechanical Systems
MEAM 564	The Principles and Practice of Microfabrication Technology

Select 2 more MEAM graduate courses, level 500 and above. 2

Electives

Select 3 Electives: 3

ARCH 726	Furniture Design Strategic Process
CIS 560	Interactive Computer Graphics
EAS 507	Intellectual Property and Business Law for Engineers
EAS 512	Engineering Negotiation
EAS 545	Engineering Entrepreneurship I
EAS 546	Engineering Entrepreneurship II
EAS 595	Foundations of Leadership
IPD 501	Integrated Computer-Aided Design, Manufacturing and Analysis
IPD 504	Rehab Engineering and Design
IPD 509	Needfinding
IPD 511	Creative Thinking and Design
IPD 515	Product Design

IPD 525	Ergonomics/Human Factors Based Product Design
IPD 527	Industrial Design I

The degree and major requirements displayed are intended as a guide for students entering in the Fall of 2020 and later. Students should consult with their academic program regarding final certifications and requirements for graduation.
