DATA SCIENCE AND ARTIFICIAL INTELLIGENCE, MSE

Penn's Master of Science in Engineering (MSE) in Data Science & Artificial Intelligence (DATS & AI) prepares students for a wide range of data-driven and AI-powered careers, whether in technology and engineering, consulting, healthcare, science, policy-making, or understanding patterns in literature, art or communications. Building on a shared foundation in statistics, optimization, machine learning, and algorithms, students can tailor their studies through two concentrations—Data Science, which includes coursework on data management and decision making, and Artificial Intelligence, which includes coursework on building systems that can perform tasks that require human intelligence. The DATS & AI Program can typically be completed in one-and-a-half to two years.

The degree also allows students to apply what they have learned to a number of different application areas through a thesis or practicum. Potential areas of application can be explored through the many centers and institutes across campus – including trustworthy AI (the ASSET center), network science (the Warren Center for Network and Data Science), digital humanities (the Price Lab for Digital Humanities), biomedicine (the Institute for Biomedical Informatics), and public policy (the Penn Wharton Budget Model and the Annenberg Center for Public Policy) — as well as more traditional opportunities in Computer and Information Science and Electrical and Systems Engineering.

For more information: https://dats.seas.upenn.edu/program/

For students interested in learning more about **MSE-DS Online**, click here (https://online.seas.upenn.edu/degrees/mse-ds-online/).
For students interested in learning more about **MSE-AI Online**, click (https://online.seas.upenn.edu/degrees/mse-ai-online/)here (https://online.seas.upenn.edu/degrees/mse-ds-online/). (https://online.seas.upenn.edu/degrees/mse-ai-online/)

The degree and major requirements displayed are intended as a guide for students entering in the Fall of 2026 and later. Students should consult with their academic program regarding final certifications and requirements for graduation.

Curriculum

10 course units are required for the Data Science & Artificial Intelligence degree.
The ten required course units are divided into three categories: Core Courses, Concentrations, and Electives. (As long as the prerequisites for the courses are met, students can complete these courses in any sequence.)

Code	Title	Course Units
Core Requirements (4 cu's)		
Linear Algebra or Convex Optimization		
CIS 5150	Fundamentals of Linear Algebra and Optimization	1
or MATH 5130	Computational Linear Algebra	
or MATH 5140	Advanced Linear Algebra	
or ESE 6050	Modern Convex Optimization	
or STAT 5810	Convex Optimization for Statistics and Data Science	
Statistics		
ESE 5420	Statistics for Data Science	1
or STAT 5110	Statistical Inference	
or STAT 5120	Mathematical Statistics	
or STAT 5350	Forecasting Methods for Management	
or STAT 5420	Bayesian Methods and Computation	
Machine Learning		
CIS 5190	Applied Machine Learning	1
or CIS 5200	Machine Learning	
or ESE 5460	Principles of Deep Learning	
Algorithms		
CIS 5030	Algorithms for Big Data	1
or CIS 5020	Analysis of Algorithms	
or CIS 6770	Advanced Topics in Algorithms and Complexity	
Concentration (choose one)		**6**
Students are required to select one of the following tracks.		
Data Science Concentration		
CIS 5450	Big Data Analytics	
CIS 5500	Database and Information Systems	
or STAT 571	Modern Data Mining	
4 CUs of Electives (Choose courses from any of the elective buckets)		
AI Concentration		
CIS 5210	Artificial Intelligence	
CIS 5810	Computer Vision & Computational Photography	
or CIS 5300	Natural Language Processing	
or CIS 6800	Advanced Topics in Machine Perception	
or CIS 6300	Advanced Topics in Natural Language Processing	
4 CU's of Electives (Two of which should come from the ML/multimodal AI bucket)		
Total Course Units		**10**

Elective Buckets
Machine Learning, Multi-modal AI and Data Analysis

Code	Title	Course Units
CIS 5210	Artificial Intelligence	
CIS 5220	Deep Learning for Data Science	
CIS 5270	Trustworthy Machine Learning	
CIS 5300	Natural Language Processing	
CIS 5450	Big Data Analytics	
CIS 5800	Machine Perception	
CIS 5810	Computer Vision & Computational Photography	
CIS 6200	Advanced Topics in Machine Learning	
CIS 6250	Theory of Machine Learning	
CIS 6300	Advanced Topics in Natural Language Processing	

CIS 6800	Advanced Topics in Machine Perception
ESE 5140	Graph Neural Networks
ESE 5380	Machine Learning for Time-Series Data
ESE 5410	Machine Learning for Data Science
ESE 5460	Principles of Deep Learning
ESE 6180	Learning for Dynamics and Control
ESE 6450	Deep Generative Models
ESE 6500	Learning in Robotics
MSE 5760	Machine Learning and Its Applications in Materials Science
STAT 5710	Modern Data Mining

AI and Data Science for Discovery

Code	Title	Course Units
BE 5040	Biological Data Science II: Data Mining Principles for Epigenomics	
BE 5060	Introduction to Neuroengineering	
BE 5210	Brain-Computer Interfaces	
BE 5660	Networked Neuroscience	
BMIN 5030	Data Science for Biomedical Informatics	
BMIN 5200	Foundations of Artificial Intelligence in Health	
BMIN 5210	Advanced Methods and Health Applications in Machine Learning	
BMIN 5220	Natural Language Processing for Health	
BMIN 5490	Exploring Data Science Methods with Health Care Data	
CIS 5350	Introduction to Bioinformatics	
CIS 5360	Fundamentals of Computational Biology	
CIS 5370	Biomedical Image Analysis	
PHYS 5585	Theoretical and Computational Neuroscience	

Optimization, Systems and Control

Code	Title	Course Units
ESE 5000	Linear Systems Theory	
ESE 5050	Feedback Control Design and Analysis	
ESE 5060	Introduction to Optimization Theory	
ESE 6050	Modern Convex Optimization	
ESE 6060	Combinatorial Optimization	
ESE 6180	Learning for Dynamics and Control	
ESE 6190	Model Predictive Control	

Social and Network Science

Code	Title	Course Units
CIS 5230	Ethical Algorithm Design	
ECON 7300	Econometrics I: Fundamentals	
ECON 7310	Econometrics II: Methods & Models	
ECON 8310	Econometrics III: Advanced Techniques of Cross-Section Econometrics	
ECON 8320	Econometrics IV: Advanced Techniques of Time-Series Econometrics	
MKTG 7760	Applied Probability Models in Marketing	

Surveys and Statistical Methods

Code	Title	Course Units
MKTG 7120	Data and Analysis for Marketing Decisions	
OIDD 6120	Business Analytics	
STAT 5350	Forecasting Methods for Management	
STAT 6210	Accelerated Regression Analysis for Business	
STAT 7220	Predictive Analytics for Business	
STAT 9200	Sample Survey Methods	
STAT 9210	Observational Studies	
STAT 9270	Bayesian Statistical Theory and Methods	
STAT 9740	Modern Regression for the Social, Behavioral and Biological Sciences	

Data-Centric Programming

Code	Title	Course Units
CIS 5050	Software Systems	
CIS 5500	Database and Information Systems	
CIS 5520	Advanced Programming	
CIS 5550	Internet and Web Systems	
CIS 5590	Programming and Problem Solving	
CIS 5650	GPU Programming and Architecture	
CIS 5690	GPU Computing for Machine Learning Systems	
CIS 5730	Software Engineering	
CIS 6500	Advanced Topics in Databases	
CIT 5950	Computer Systems Programming	
ESE 5390	Hardware/Software Co-Design for Machine Learning	

Robotics

Code	Title	Course Units
ESE 6150	RoboRacer Autonomous Racing Cars	
ESE 6500	Learning in Robotics	
MEAM 5200	Introduction to Robotics	
MEAM 6200	Advanced Robotics	

Simulation

Code	Title	Course Units
CBE 5250	Molecular Modeling and Simulations	
CBE 5440	Computational Science of Energy and Chemical Transformations	
CBE 5590	Multiscale Modeling of Chemical and Biological Systems	
MEAM 5270	Finite Element Analysis	

MEAM 5610	Thermodynamics: Foundations, Energy, Materials	
MEAM 6460	Computational Mechanics	

Mathematical and Algorithmic Foundations

Code	Title	Course Units
AMCS 5141	Advanced Linear Algebra	
CIS 5020	Analysis of Algorithms	
CIS 5030	Algorithms for Big Data	
CIS 6250	Theory of Machine Learning	
CIS 6770	Advanced Topics in Algorithms and Complexity	
CIT 5960	Algorithms and Computation	
ENM 5020	Numerical Methods and Modeling	
ENM 5310	Data-driven Modeling and Probabilistic Scientific Computing	
ESE 5030	Simulation Modeling and Analysis	
ESE 5060	Introduction to Optimization Theory	
ESE 5450	Data Mining: Learning from Massive Datasets	
ESE 6050	Modern Convex Optimization	
ESE 6740	Information Theory	
OIDD 9300	Stochastic Models	
STAT 5150	Advanced Statistical Inference I	
STAT 9270	Bayesian Statistical Theory and Methods	

Other Electives

Code	Title	Course Units
CIS 5120	Introduction to Human Computer Interaction	
CIS 7000	Special Topics Only relevant data science / AI topics upon approval	

Thesis / Practicum

Code	Title	Course Units
DATS 5990	Master's Independent Study (1 or 2 cu's of Practicum Total (1 cu per semester)) DATS Practicum and Thesis courses are not mandatory	
DATS 9990	Master's Thesis (2 cu's total needed (consecutive semesters)) DATS Practicum and Thesis courses are not mandatory	

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First Year	
Fall	
Three courses (3 cu's) [1]	3
Course Units	**3.00**
Spring	
Three courses (3 CU's)	3
Course Units	**3.00**
Second Year	
Fall	
Three courses (3 CU'S)	3
Course Units	**3.00**
Spring	
One Course (1 CU)	1
Course Units	**1.00**
Total Course Units	**10.00**