



Data Science Program – Engineering

For students who matriculated into CoE in Fall 2015 or later.
Fall 2015 – Summer 2022 Guide

Welcome!

Thank you for your interest in the Data Science program in the College of Engineering. The fast rate of growth of data and interest in its analysis has created many new and exciting opportunities for students with Data Science undergraduate degrees.

Data Science draws from both Computer Science and Statistics, and its scope includes methods and algorithms involved in collecting, curating, managing, analyzing, and transforming data into information so as to enable knowledge creation and decision-making in a variety of application domains. Within business and industry, applications range from transactional data captured by companies, data on the internet and social media, to sensor data captured by smart phones, automobiles, industrial systems, security, and environmental networks. Scientists also need data science techniques for drug discovery, analyzing GenBank DNA sequences, understanding environmental data, and improving healthcare by leveraging data. While these developments have been happening over the last two decades, what is new is the massive increase in scale in three dimensions: *volume* of data collected, *variety* and heterogeneity in data types, and *velocity* of data (such as streaming data in VOIP, video games and others).

Your path through a DS-Eng degree will involve taking the same core computer science classes (EECS 280, EECS 203, EECS 281) as computer science majors, and the same fundamental statistics classes as statistics majors (STATS 412 and STATS 413). You will take courses in machine learning, data management, and the application of data science in another academic discipline. Your technical electives will let you either specialize in an area you wish to pursue, or give you a broad foundation in computer science, statistics, and mathematics. Finally, you will complete a capstone project in a team and learn to present your technical work to others. To provide exposure to application domains and to broader issues in data science, the program includes technical electives from several units including the College of Engineering; the College of Literature, Science & the Arts; and the School of Information.

Data scientists can apply their skills in many different places -- healthcare, manufacturing, finance, journalism, geography, bioinformatics, and web analytics to name only a few. A Data Science degree will give you depth in both computer science and statistics. Together, these skills will allow you to design experiments that collect the right kinds of data, understand the methods used to analyze that data to draw valid conclusions, and design and implement algorithms (including machine learning algorithms) to produce actionable results.

Data Science - College of Engineering (DS-Eng) Declaration Requirements

To declare a major in DS-Eng, you must be a College of Engineering student and:

- (1) Have completed at least one full term at UM Ann Arbor
- (2) Have an overall UM GPA of 2.0 or better in courses taken at the UM Ann Arbor campus and be in good standing
- (3) Have completed or earned credit by exam or transfer for at least one course in each of these categories
 - a. Calculus (e.g. Math 115, 116, 120, 156)
 - b. Calculus-based physics lectures (e.g. Physics 140, 160) or chemistry lectures (e.g. Chem 130)
 - c. Required engineering courses (Engr 100, 101, 151)

If you are interested in declaring a DS-Eng major and do not meet these requirements, please schedule an appointment with the DS-Eng Chief Program Advisor (CPA) to discuss your situation.

**THIS DOCUMENT DESCRIBES THE DATA SCIENCE PROGRAM REQUIREMENTS ONLY FOR
STUDENTS IN THE COLLEGE OF ENGINEERING**

U-M offers two paths to an undergraduate degree in Data Science: one for students in the College of LSA and another for students in the College of Engineering. Students in the College of LSA should visit the advising office in the LSA Statistics department to learn more about Data Science through LSA.

Undergraduate Advising

If you are a DS-Eng Major or considering becoming one, we recommend that you **see a DS-Eng Faculty Advisor** every term, even if you know what courses you want to take. There may be options or constraints of which you are unaware. Frequent meetings with an advisor will help ensure that you get the most out of your education here and that there are no surprises when you apply for your diploma. To schedule an appointment with a DS-Eng Faculty Advisor, visit cse.engin.umich.edu/academics/for-current-students/advising/.

For routine questions not covered by this Program Guide, such as whether a course will satisfy a particular requirement, you have several options:

- Check the CSE Advising web page (cse.engin.umich.edu/academics/for-current-students/advising/) for information about registration procedures, course offerings, book lists, time schedules, advising hours, and career planning advice.
- You may also e-mail the CSE Advising Office at ugadmin@eecs.umich.edu, or the DS-Eng Chief Program Advisor at dsengadvisor@umich.edu, or visit CSE Advising at 2808 BBB.

DS-Eng Program Requirements & Policies

College of Engineering Core Requirements

1. Engineering 100, and [Engineering 101 or Engineering 151 or EECS 180 AP credit]
2. [Chemistry 125, Chemistry 126, and Chemistry 130] or [Chemistry 210 and Chemistry 211]
3. Physics 140, Physics 141, Physics 240, and Physics 241
4. Math:
 - a. Math 115 or Math 120 (AP)
 - b. Math 116 or Math 121 (AP)
 - c. Math 214 (can also be satisfied with Math 217, Math 417, Math 419, or Robotics 101)
 - d. Math 215 or Math 216 (If both Math 215 and Math 216 are taken, Math 216 can count as a Flexible Technical Elective.)
5. Intellectual Breadth: rules for this College requirement can be found in the CoE Bulletin under the “Intellectual Breadth” heading at <https://bulletin.engin.umich.edu/ug-ed/reqs/>.
6. General Electives: 15 credits are “required”; CoE degrees require 128 total credits, and more or fewer GE credits may be needed to achieve this total depending on individual factors in a student’s record.

Program Core

The below required courses form the intellectual core of computing and statistics.

- EECS 203 (4 credits): Discrete Mathematics. *Acceptable alternative: Math 465 plus one additional credit of Advanced Technical Elective*
- EECS 280 (4 credits): Programming and Elementary Data Structures
- EECS 281 (4 credits): Data Structures and Algorithms
- STATS 412 (3 credits): Introduction to Probability and Statistics**
- STATS 413 (4 credits): Applied Regression Analysis

**You should not take STATS 412 in certain circumstances. See below for alternative options.

I have finished:	If I then take:	I will have fulfilled this requirement:	Notes
STATS 180 (AP)	STATS 425	STATS 412 only	
STATS 250	STATS 425	STATS 412 + 3 cr. Adv. Tech Electives	
STATS 280	STATS 425	STATS 412 + 3 cr. Adv. Tech Electives	
STATS 425	STATS 426*	STATS 412 + 3 cr. Adv. Tech Electives	
EECS 301	STATS 426*	STATS 412 + 3 cr. Adv. Tech Electives	

ECON 451	STATS 425	STATS 412 + 3 cr. Adv. Tech Electives	<i>completing ECON 452 will then also satisfy STATS 413 requirement</i>
IOE 265	IOE 366 + (STATS 425 or 426*)	STATS 412 + STATS 413 + 3 cr. Adv. Tech Electives	

*STATS 425 is a prerequisite for STATS 426.

- One course from each of the three following categories is required:
 - *Machine learning and data mining elective*: **EECS 445 or STATS 415**. Both these courses draw on techniques from statistics, computing, and linear algebra to provide a comprehensive introduction to machine learning and applications to a variety of domains. Students may pursue both courses for different perspectives, though there is some content overlap—one will count as Adv. Tech. Elective.
 - *Data management and applications elective*: **EECS 484 or EECS 485**. These courses introduce the concept of databases, which are applicable to storing and querying large datasets.
 - *Data science applications elective (3 credits)*: A student must take at least one upper-level course related to data science applications (e.g. computer vision, robotics, healthcare, biology, finance, chemistry, sensor-based systems, and security). Visit the DS-Eng website for the current list of approved courses that satisfy this requirement. **Advanced Technical Electives & Capstone Experience**

Students must complete at least 8 credits of Advanced Technical Electives for Data Science, and 4 credits of an approved DS Capstone course, for a total of 12 credits. If a 3-credit Capstone is elected, one additional credit of Advanced Technical Elective must be completed. Adv. TE courses and Capstone information can be found on the website at cse.engin.umich.edu/academics/undergraduate/data-science-eng/ds-eng-electives-and-capstone-courses/

The DS Capstone is typically pursued during the senior year. Schedule an appointment with a DS-Eng Faculty Advisor for assistance in determining appropriate Capstone pathways. Options for this requirement include:

- An approved Capstone course (list found at <https://cse.engin.umich.edu/academics/undergraduate/data-science-eng/ds-eng-electives-and-capstone-courses/>)
- An approved data science-oriented project via existing course, or independent study (EECS 499 or STATS 489). If a course/independent study project has substantial data science components, students may seek approval to use it as the Capstone. Projects focused on software development are likely insufficient unless there is also substantial data analysis or work on other data issues. Students must seek a first read on the suitability of the course by submitting a proposal to dsengadvisor@umich.edu at the beginning of the course, and must submit a final project report and cover letter at the end of the course to dsengadvisor@umich.edu, pointing out the main data science features of the project. The approval process may be used for both established courses and independent study courses. No project is guaranteed approval.

Flexible Technical Electives

Students must complete 11 credits chosen from approved Flexible Technical Electives. These courses help provide domain-specific experience that could be useful later for applying data science techniques to other domains, and can be taken in other departments. The current list of approved courses that satisfy this requirement can be found at cse.engin.umich.edu/academics/undergraduate/data-science-eng/ds-eng-electives-and-capstone-courses/. Excess credits from DS Advanced Technical Elective courses can be applied toward Flexible Technical Electives, though students cannot use the same credits toward both requirements.

Technical Communication and Professionalism

Three courses related to technical communication and professionalism are required:

- Technical Communications: TCHNCLCM 300 (must be taken in a semester prior to the Capstone).
- Computer professionalism: EECS 496
- Writing and oral presentation (one of the following):
 - STATS 404
 - STATS 485—if using this course toward this requirement and the Capstone requirement, 3 additional credits of Advanced Technical Electives must be completed.
 - TCHNCLCM 496 or TCHNCLCM 497 or TCHNCLCM 499 (499 requires approval from the Tech. Comm. department).
 - These courses must be taken in the same or later term as the Capstone

General Advice

- Feeling stressed, depressed, or just need someone to talk to? There are many places to find support on campus. A list of resources is found at <https://care.engin.umich.edu/student-support-services/>.
- You should aim to **complete the machine learning/data mining requirement in your junior year** or the first semester of your senior year. This will give you more options for your capstone experience course.
- Many of the EECS courses tend to be project-oriented (e.g, 4-5 projects in a semester), with substantial programming or project design. It is generally a good idea to **mix programming and non-programming courses** in each semester when possible.
- It is recommended that you **meet with an advisor regarding your Technical Electives prior to enrolling** in them to make sure that the electives are collectively appropriate for your goals.
- Double-majoring in CS-ENG and DS-ENG is not allowed.

Course Sequencing and Workload:

- Student feedback about workload in EECS courses can be found online: <http://cse.engin.umich.edu/academics/course-information/workload-surveys/>. For additional information on workload of all university courses, including Statistics courses, please explore Atlas at <https://atlas.ai.umich.edu/>.

DS-Eng Sample Schedule (Fall 2015 – Summer 2022)

The sample schedule below summarizes the program requirements. *Note that General Electives are intended to help students reach 128 total credits required for graduation and may vary from student to student, with 15 credits being the maximum needed. Please discuss with your advisor if you are unsure of the necessary number of General Elective credits for your degree.*

Data Science in Engineering	Total	1	2	3	4	5	6	7	8
Subjects Required by all Programs (55 credits)									
Mathematics 115, 116, and (214 or 217)	12	4	4		4				
Mathematics 215	4			4					
Engineering 100, Introduction to Engineering	4		4						
Engineering 101, Introduction to Computers	4	4							
Chemistry 125/126 and 130, or Chemistry 210 and 211	5	5							
Physics 140 and Lab 141	5			5					
Physics 240 and Lab 241	5				5				
Intellectual Breadth	16	4			4	4	4		
Program Core (30 credits)									
Discrete Mathematics: EECS 203 or MATH 465	4		4						
EECS 280, Programming and Elementary Data Structures	4		4						
EECS 281, Data Structures and Algorithms	4			4					
STATS 412, Introduction to Probability & Statistics	3				3				
STATS 413, Applied Regression Analysis	4					4			
Databases and Applications: EECS 484 or EECS 485	4						4		
Machine Learning/Data Mining: EECS 445 or STATS 415	4					4			
Data Science Applications elective (see online list)	3								3
Advanced Technical Electives and Capstone (12 credits)									
Advanced Technical Electives in Data Science. 300-level or higher from online list of approved courses, or with advisor approval prior to taking the course.	8						4		4
Capstone Experience Course	4							4	
Other Requirements									
Flexible Technical Electives. 200-level or higher from a pre-approved list of courses, or with advisor approval prior to taking the courses.	11					4		4	3
TCHNCLCM 300	1						1		
EECS 496 Major Design Experience Professionalism	2							2	
TCHNCLCM 496, TCHNCLCM 497, TCHNCLCM 499, STATS 404, or STATS 485	2							2	
General Electives (15 credits) – See note above	15			3			3	3	6
Total	128	17	16	16	16	16	16	15	16

EECS Grading & Repeat Policies

A grade of C- or below in any of the College Core or any DS-Eng major requirements is considered a failing grade and the course must be repeated or substituted with another. [Note: Grades of C- through D- are acceptable for Intellectual Breadth requirements or for general electives.] Students are limited to attempting each of the three 200-level courses (EECS 203, EECS 280, EECS 281) at most twice. An attempt includes, but is not limited to, a notation of any letter grade (“A-F”), withdraw (“W”), Pass/Fail (“P”/“F”), Transfer (“T”), or Incomplete (“I”) posted on your U-M transcript. Exceptions to this rule can be granted *only in extraordinary circumstances*; students in these circumstances should contact the CSE Advising Office for instruction.