



Data Science Program – Engineering

For students who matriculated into CoE in Fall 2015 or later.
Fall 2015 – Summer 2021 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).

The Data Science program emphasizes fundamental methods from the fields of computer science, statistics, and mathematics that are essential for analyzing the growing amount of data generated in today's business, science, and engineering applications. Furthermore, the program exposes students to a variety of application domains through threads of upper-level electives, including issues of ethics, privacy, and security.

The Data Science program will also include courses that provide capstone project experience that applies coursework to open-ended data science problems. Typically, a team of students will work on analyzing, modeling, and visualizing real-world datasets as part of such projects.

The new Data Science program is multi-disciplinary. All students will take courses in Computer Science, Statistics, and Mathematics, complementing them with application of data analytics techniques to application domains to provide a multidisciplinary degree to develop future generations of data scientists. 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 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 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, scheduling advising appointments, 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

Program Core

The below required courses form the intellectual core of computing and statistics. These courses are necessary to provide a solid foundation for pursuing advanced technical courses in Data Science at 300-level and higher.

- EECS 203 (4 credits): Discrete Mathematics. *Acceptable alternative: Math 465.*
- 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 or 412	STATS 412 only	<i>credit for 180 will be lost if STATS 250 is taken</i>
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	STATS 425 or 426*	STATS 412 + 3 cr. Adv. Tech Electives	<i>completing IOE 366 will then also satisfy STATS 413 requirement</i>
IOE 265	IOE 366	STATS 412 + 3 cr. Flex Tech Electives	<i>completing STATS 425 or 426 will then also satisfy STATS 413 req.</i>

*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. This requirement should be taken in junior year or first term of senior year, as that will provide more options for your Capstone experience course.
 - *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. A 3-credit Capstone course is permitted. If a 3 credit Capstone is elected, one additional credit of Advanced Technical Elective must be completed. Advanced Technical Elective courses and Capstone information can be found at cse.engin.umich.edu/academics/undergraduate/data-science-eng/ds-eng-electives-and-capstone-courses/.

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. Additionally, you should check on the current term's EECS special topics offerings (398/498/598), as some of them may be applicable towards Advanced Technical Electives or other requirements. A list for each term's offerings, and what DS requirements they satisfy, can be found at <https://cse.engin.umich.edu/academics/course-information/special-topics-courses/>.

The DS Capstone is typically pursued during the senior year. Schedule an appointment with a DS-Eng 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*
 - 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*

*STATS 485 (3 credits) can be used for either the Capstone requirement or the Writing and Oral Presentation requirement. Or, if desired, its credits can be split across both: 1 credit for Capstone and 2 credits for the Writing and Oral Presentation requirement. With this structure, both the Capstone and Writing and Oral Presentation requirements are considered satisfied, but 11 credits of Advanced Technical Electives are then required to meet the 12 credits required across the combined Advanced Technical Electives + Capstone area.

Courses That Meet Multiple Requirements: One course cannot be used to satisfy more than one requirement at the same time. For instance, if a course is on the approved list for both Advanced Technical Electives and Application Electives, the credits from the course can be assigned to either Advanced TE or Application Elective, but not both requirements. Credits can be split up among two requirements where appropriate.

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 ossa.engin.umich.edu/onoff-campus-resources/.
- Many of the EECS courses tend to be project-oriented with typically 4-5 projects in a semester and with substantial programming or project design. It is generally a good idea to mix programming and non-programming courses in each semester when possible.
- Machine learning has a relationship to the area of optimization. The Industrial and Operations Engineering (IOE) department offers IOE 310 and follow-on courses in optimization. If you plan to take IOE 310, consider taking IOE 202 and Math 214 early, as they are both enforced prerequisites for 310. Additionally, IOE 202 only permits students below 85 credits to enroll.
- CSE offers the opportunity to pursue a MS in Computer Science to its undergraduate students. Data Science students are eligible to apply to the program. See the additional prerequisites that may apply and deadlines on the links at <https://cse.engin.umich.edu/academics/for-current-students/undergraduate-advising/graduate-school-for-current-u-m-undergraduates/>.

DS-Eng Sample Schedule (Fall 2015 – Summer 2021)

The sample schedule below summarizes the program requirements.

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)	15			3			3	3	6
Total	128	17	17	16	16	15	16	15	16

EECS Grading & Repeat Policies

A grade of C- or below in any of the College Core or any DS-Eng major requirement 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.