



Data Science Program – Engineering

For students who matriculate into CoE Fall 2015 or later.
Fall 2015 – Summer 2017 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, 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 Office Information

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 <http://www.eecs.umich.edu/eecs/undergraduate>.

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 EECS Advising web page, <http://www.eecs.umich.edu/eecs/undergraduate>, for information about registration procedures, course offerings, book lists, time schedules, advising hours, and career planning advice.
- You may also e-mail the DS-Eng Undergraduate Program Coordinator or the DS-Eng Chief Program Advisor at dsengadvisor@umich.edu, or visit the EECS-CSE Undergraduate Advising Office at 2808 BBB.

This document covers rules and advice for the DS-Eng program that came into effect in Fall 2015. Your program is determined by the rules that are in effect when you entered the College of Engineering.

DS-Eng Program Requirements & Policies

Program Core

- 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

The above 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.

- Every student in a Data Science program will take at least one course from each of the three following categories as part of the core requirements:
 - *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. Credit is granted for only one course since the two courses have significant overlap in content.
 - *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

Students must take at least 8 credits of Advanced Technical Electives for Data Science. Visit the DS-Eng website for the current list of approved courses that satisfy this requirement.

Flexible Technical Electives

All 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. Visit the DS-Eng website (eecs.umich.edu/eecs/undergraduate/data-science/) for the current list of approved courses that satisfy this requirement. Credits from DS Advanced Technical Elective courses can also be applied toward Flexible Technical Electives, though students cannot use the same credits towards both requirements.

Capstone Experience

A 4-credit capstone data science project must be taken, typically during the senior year. Note that for Capstone experiences that are 3 credits, you must take an additional advanced technical elective credit to reach the 4 credits required. (*Note: MDE courses approved for CS-Eng are not necessarily also approved to count for the Data Science program.*) Options for this requirement include:

- An approved capstone course (see the DS-Eng website: eecs.umich.edu/eecs/undergraduate/data-science/)
- An approved data science-oriented independent study project (EECS 499 or STATS 489). The independent study can include a project that is supported by a company or work with data from other departments as long as students have a faculty mentor in EECS or STATS who is engaged in the project and is able to assign a grade to EECS 499 or STATS 489 (Selection of EECS vs. STATS should be made based on project content/area). Approval is required from a Data Science advisor in advance of the project, and the final project report must be submitted and approved by the faculty mentor. A link to or a copy of the project report must be provided to the appropriate advising office at the completion of the study.

Technical Communication and Professionalism

Three courses related to technical communication and professionalism must be taken.

- 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
 - Taken concurrently with the capstone experience course, TCHNCLCM 496 or TCHNCLCM 497 or TCHNCLCM 499 (499 requires approval from the Tech. Comm. department).

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 Free 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. At most one attempt from Summer 2014 and earlier will count against this limit. Exceptions to this rule can be granted *only in extraordinary circumstances*; students in these circumstances should contact the CSE Undergraduate Advising Office for instruction.

General Advice

- If you are considering the Data Science major, **do not take STATS 250** (or any of the CS-Eng-approved Stats alternatives, such as IOE 265, EECS 301, EECS 401, etc.). You must instead take STATS 412. The Statistics department does not allow full credit for both STATS 250 and STATS 412, and STATS 250 is not sufficient preparation in statistics and probability foundations for Data Science. If you have already taken STATS 250 or one of the alternatives listed above, please see a Data Science advisor to discuss how to ameliorate the lack of STATS 412.
- 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 a given semester when you can.
- Taking more advanced classes earlier (e.g., as a junior) can be helpful when you are looking for internships.
- If you are considering a **TCHNCLCM 400-level course**, make sure you take it in the same semester as your capstone experience course.
- It is recommended that you **meet with an advisor regarding your Technical Electives prior to enrolling** in them to make sure that the electives collectively are appropriate for your goals and to confirm that they will apply towards the major.

DS-Eng Sample Schedule (Fall 2015 – Summer 2017)

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	1	8
Total	128	17	17	16	16	15	16	15	16