DATA SCIENCES, B.S. (ENGINEERING)

Begin Campus: Any Penn State Campus
End Campus: University Park

Program Description
Data Sciences is a field of study concerned with developing, applying, and validating methods, processes, systems, and tools for drawing useful knowledge, justifiable conclusions, and actionable insights from large, complex and diverse data through exploration, prediction, and inference. Data Sciences integrate aspects of Computer Science, Informatics, and Statistics to yield powerful data science methods, systems, tools, and best practices that find applications across a broad range of application domains. The curriculum for the major is designed to equip students with the knowledge and the skills needed to elicit, formulate, and solve data sciences problems using modern data science methods, tools, and best practices for data management, data exploration, data integration, predictive modeling (using machine learning), and effectively communicate their findings to, and collaborate with a broad range of stakeholders. The students will gain the critical analytical skills needed to assess the feasibility, benefits, effectiveness, limitations, risks, and ethical implications of applying data sciences methods in different settings. Experiences such as the capstone project prepare students to function effectively as members of interdisciplinary data science teams to harness the potential of data to enable discovery, optimize products and processes, and inform decisions. As distinct from majors that focus primarily on developing data science knowledge and skills to support inquiry in other domains, the primary focus of the Data Sciences major is on the development, evaluation, application, and validation of the data science tools themselves. All students in the major receive in-depth training in data sciences through a set of core courses. Additionally, data sciences students specialize in one of the following options: applied, computational, or statistical modeling data sciences, as described below.

Applied Data Sciences (DATSC_BS)
Only available through the College of Information Sciences and Technology

The students in the Applied DS option will receive exposure to an application domain so they are equipped to formulate and solve data science problems drawn from the chosen domain, e.g., life and health sciences, business, behavioral and cognitive sciences, physical sciences, agricultural sciences, among others.

Computational Data Sciences (DTSCE_BS)
Only available through the College of Engineering

The students in the Computational DS option will receive additional training in Computer Science to be able to design, analyze, implement, and deploy advanced algorithms, hardware and software architectures, and systems for data management and analyses.

Statistical Modeling Data Sciences (DTSCS_BS)
Only available through the Eberly College of Science

The students in the Statistical modeling DS option will receive additional training in Statistics to be able to formulate, develop, and apply the proper statistical models and methods for data analyses, e.g., experiment design, sampling, hypotheses testing, and limiting false discovery.

What is Data Sciences?
Data Sciences is a field that explores the methods, systems, and processes used to extract knowledge from data and turn these insights into discoveries, decisions, and actions. The emergence of massive amounts of data – also known as “big data” – found in our world through healthcare records, human sensors, digital media, and a number of other sources has increased the need for individuals who can obtain useful knowledge from big data and apply it to address major societal challenges across a variety of fields. Students pursuing this degree will develop the knowledge and skills needed to manage and analyze large-scale, unstructured data to address an expanding range of problems in industry, government, and academia.

MORE INFORMATION ABOUT DATA SCIENCES (https://ist.psu.edu/prospective/undergraduate/academics/data-sciences/)

You Might Like This Program If...
- You are curious about analyzing information to discover new insights.
- You want to apply data analytics to make strategic decisions.
- You want to understand how data can be used to visualize phenomena and predict different outcomes.
- You are interested in statistics, mathematics, and the social sciences, and want to combine these disciplines to understand what data is really telling us.

MORE INFORMATION ABOUT WHY STUDENTS CHOOSE TO STUDY DATA SCIENCES (https://ist.psu.edu/prospective/undergraduate/academics/data-sciences/)

Entrance to Major
To be eligible for entrance into the Data Sciences major, a degree candidate must satisfy requirements for entrance to the major.

Specific entrance requirements include:

1. The degree candidate must be taking, or have taken, a program appropriate for entry to the major as shown in the bulletin.
2. The degree candidate must complete the following entrance-to-major requirements: CMPSC 121* or CMPSC 131*, CMPSC 122* or CMPSC 132*, MATH 140*, MATH 141*, STAT 200* or DS 200*. These courses must be completed by the end of the semester during which the entrance to major process is carried out.

* Course requires a grade of C or better.

Degree Requirements
For the Bachelor of Science degree in Data Sciences, a minimum of 123 credits is required:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Credits</th>
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<tbody>
<tr>
<td>General Education</td>
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<tr>
<td>Electives</td>
<td>3-12</td>
</tr>
<tr>
<td>Requirements for the Major</td>
<td>72-81</td>
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</table>

6 of the 45 credits for General Education are included in the Requirements for the Major. This includes: 6 credits of GQ courses.
Requirements for the Major

To graduate, a student enrolled in the major must earn a grade of C or better in each course designated by the major as a C-required course, as specified by Senate Policy 82-44 ([https://senate.psu.edu/policies-and-rules-for-undergraduate-students/82-00-and-83-00-degree-requirements/#82-44](https://senate.psu.edu/policies-and-rules-for-undergraduate-students/82-00-and-83-00-degree-requirements/#82-44)).

Common Requirements for the Major (All Options)

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Prescribed Courses</td>
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<tr>
<td>DS 220</td>
<td>Data Management for Data Sciences</td>
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<tr>
<td>DS 340W</td>
<td>Applied Data Sciences</td>
<td>3</td>
</tr>
<tr>
<td>DS 435</td>
<td>Ethical Issues in Data Science Practice</td>
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<td>MATH 140</td>
<td>Calculus With Analytic Geometry I</td>
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<tr>
<td>MATH 141</td>
<td>Calculus with Analytic Geometry II</td>
<td>4</td>
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<td>MATH 220</td>
<td>Matrices</td>
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<tr>
<td>STAT 184</td>
<td>Introduction to R</td>
<td>2</td>
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<tr>
<td>STAT 380</td>
<td>Data Science Through Statistical Reasoning and Computation</td>
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</tbody>
</table>

Additional Courses

**Additional Courses: Require a grade of C or better**

Select 1 credit from the following:

1. First-Year Seminar
2. CMPSC 121 Introduction to Programming Techniques
3. CMPSC 360 Discrete Mathematics for Computer Science
4. CMPSC 410 Programming and Computation I: Fundamentals
5. CMPSC 412 Intermediate Programming
6. CMPSC 416 Artificial Intelligence
7. CMPSC 418 Machine Learning and Algorithmic AI
8. CMPSC 461 Programming Language Concepts
9. DS/CMPSC 465 Data Structures and Algorithms
10. DS/CMPSC 470 Programming Models for Big Data
11. DS/CMPSC 492 Internship
12. IST 441 Information Retrieval and Organization
13. IST 442 Information Technology in an International Context

Supporting Courses and Related Areas

- Select 12 credits from the lists of Application Focus courses; 6 credits must at the 300- or 400-levels.
- Select 3 credits from the following:
  - STAT/MATH 318 Elementary Probability
  - STAT/MATH 414 Introduction to Probability Theory
  - STAT/MATH 418 Introduction to Probability and Stochastic Processes for Engineering
  - IST 230 Language, Logic, and Discrete Mathematics
  - CMPSC 360 Discrete Mathematics for Computer Science

LIST OF APPLIED DATA SCIENCES COURSES ([https://bulletins.psu.edu/undergraduate/colleges/information-sciences-technology/data-sciences-bs/#suggestedacademicplan#text](https://bulletins.psu.edu/undergraduate/colleges/information-sciences-technology/data-sciences-bs/#suggestedacademicplan#text))

Computational Data Sciences (DTSCE_BS): 47 credits

Only Available through the College of Engineering

<table>
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<tr>
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<td><strong>Prescribed Courses: Require a grade of C or better</strong></td>
<td></td>
</tr>
<tr>
<td>CMPSC 221</td>
<td>Object Oriented Programming with Web-Based Applications</td>
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<tr>
<td>CMPSC 360</td>
<td>Discrete Mathematics for Computer Science</td>
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<tr>
<td>CMPSC 442</td>
<td>Artificial Intelligence</td>
<td>3</td>
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<tr>
<td>CMPSC 448</td>
<td>Machine Learning and Algorithmic AI</td>
<td>3</td>
</tr>
<tr>
<td>CMPSC 461</td>
<td>Programming Language Concepts</td>
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<tr>
<td>CMPSC 465</td>
<td>Data Structures and Algorithms</td>
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<tr>
<td>DS/CMPSC 410</td>
<td>Programming Models for Big Data</td>
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<td>MATH 230</td>
<td>Calculus and Vector Analysis</td>
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<tr>
<td>STAT/MATH 414</td>
<td>Introduction to Probability Theory</td>
<td>3</td>
</tr>
<tr>
<td>STAT/MATH 415</td>
<td>Introduction to Mathematical Statistics</td>
<td>3</td>
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</tbody>
</table>

Additional Courses

Select 6 credits from Computational Option List A in Appendix C

Supporting Courses and Related Areas

- Select 3 credits from the following:
  - IST 230 Language, Logic, and Discrete Mathematics
  - CMPSC 360 Discrete Mathematics for Computer Science

LIST OF COMPUTATIONAL DATA SCIENCES COURSES ([http://www.eecs.psu.edu/students/undergraduate/Data-Sciences.aspx](http://www.eecs.psu.edu/students/undergraduate/Data-Sciences.aspx))
Statistical Modeling Data Sciences (DTSCS_BS): 38 credits
Only Available through the Eberly College of Science

Prescribed Courses

<table>
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</tr>
<tr>
<td>STAT/MATH 414</td>
<td>Introduction to Probability Theory</td>
<td>3</td>
</tr>
<tr>
<td>STAT/MATH 415</td>
<td>Introduction to Mathematical Statistics</td>
<td>3</td>
</tr>
<tr>
<td>STAT 440</td>
<td>Computational Statistics</td>
<td>3</td>
</tr>
<tr>
<td>STAT 462</td>
<td>Applied Regression Analysis</td>
<td>3</td>
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</table>

Additional Courses

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<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>DS 200</td>
<td>Introduction to Data Sciences</td>
<td>4</td>
</tr>
<tr>
<td>or STAT 200</td>
<td>Elementary Statistics</td>
<td>3</td>
</tr>
<tr>
<td>DS 310</td>
<td>Machine Learning for Data Analytics</td>
<td>3</td>
</tr>
<tr>
<td>or CMPSC 448</td>
<td>Machine Learning and Algorithmic AI</td>
<td>3</td>
</tr>
<tr>
<td>MATH 311W</td>
<td>Concepts of Discrete Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>or CMPSC 360</td>
<td>Discrete Mathematics for Computer Science</td>
<td>3</td>
</tr>
</tbody>
</table>

Supporting Courses and Related Areas
Select 6 credits from Statistical Modeling Option List A courses, see Appendix D

Select 6 credits from Statistical Modeling Option List B courses, see Appendix D

1 Students may apply up to 3 credits of ROTC as option list credits and 3 credits of ROTC as GHW credits.

LIST OF STATISTICAL MODELING DATA SCIENCES COURSES (https://bulletins.psu.edu/undergraduate/colleges/berly-science/data-sciences-bs/#suggestedacademicplantext)

General Education

Connecting career and curiosity, the General Education curriculum provides the opportunity for students to acquire transferable skills necessary to be successful in the future and to thrive while living in interconnected contexts. General Education aids students in developing intellectual curiosity, a strengthened ability to think, and a deeper sense of aesthetic appreciation. These are requirements for all baccalaureate students and are often partially incorporated into the requirements of a program. For additional information, see the General Education Requirements (https://bulletins.psu.edu/undergraduate/general-education/baccalaureate-degree-general-education-program/) section of the Bulletin and consult your academic adviser.

The keystone symbol appears next to the title of any course that is designated as a General Education course. Program requirements may also satisfy General Education requirements and vary for each program.

Foundations (grade of C or better is required and Inter-Domain courses do not meet this requirement.)
- Quantification (GQ): 6 credits
- Writing and Speaking (GWS): 9 credits

Breadth in the Knowledge Domains (Inter-Domain courses do not meet this requirement.)
- Arts (GA): 3 credits
- Health and Wellness (GHW): 3 credits
- Humanities (GH): 3 credits

Prescribed Courses: Require a grade of C or better
- MATH 230 Calculus and Vector Analysis
- STAT/MATH 414 Introduction to Probability Theory
- STAT/MATH 415 Introduction to Mathematical Statistics
- STAT 440 Computational Statistics
- STAT 462 Applied Regression Analysis

Additional Courses: Require a grade of C or better
- DS 200 Introduction to Data Sciences
- or STAT 200 Elementary Statistics
- DS 310 Machine Learning for Data Analytics
- or CMPSC 448 Machine Learning and Algorithmic AI
- MATH 311W Concepts of Discrete Mathematics
- or CMPSC 360 Discrete Mathematics for Computer Science

Supporting Courses and Related Areas
Select 6 credits from Statistical Modeling Option List A courses, see Appendix D
Select 6 credits from Statistical Modeling Option List B courses, see Appendix D

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LIST OF STATISTICAL MODELING DATA SCIENCES COURSES (https://bulletins.psu.edu/undergraduate/colleges/berly-science/data-sciences-bs/#suggestedacademicplantext)

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- Quantification (GQ): 6 credits
- Writing and Speaking (GWS): 9 credits

Breadth in the Knowledge Domains (Inter-Domain courses do not meet this requirement.)
- Arts (GA): 3 credits
- Health and Wellness (GHW): 3 credits
- Humanities (GH): 3 credits

Integrative Studies
- Inter-Domain Courses (Inter-Domain): 6 credits

Exploration
- GN, may be completed with Inter-Domain courses: 3 credits
- GA, GH, GN, GS, Inter-Domain courses. This may include 3 credits of World Language course work beyond the 12th credit level or the requirements for the student’s degree program, whichever is higher: 6 credits

University Degree Requirements

First Year Engagement
All students enrolled in a college or the Division of Undergraduate Studies at University Park, and the World Campus are required to take 1 to 3 credits of the First-Year Seminar, as specified by their college First-Year Engagement Plan.

Other Penn State colleges and campuses may require the First-Year Seminar; colleges and campuses that do not require a First-Year Seminar provide students with a first-year engagement experience.

First-year baccalaureate students entering Penn State should consult their academic adviser for these requirements.

Cultures Requirement
6 credits are required and may satisfy other requirements
- United States Cultures: 3 credits
- International Cultures: 3 credits

Writing Across the Curriculum
3 credits required from the college of graduation and likely prescribed as part of major requirements.

Total Minimum Credits
A minimum of 120 degree credits must be earned for a baccalaureate degree. The requirements for some programs may exceed 120 credits. Students should consult with their college or department adviser for information on specific credit requirements.

Quality of Work
Candidates must complete the degree requirements for their major and earn at least a 2.00 grade-point average for all courses completed within their degree program.

Limitations on Source and Time for Credit Acquisition
The college dean or campus chancellor and program faculty may require up to 24 credits of course work in the major to be taken at the location or in the college or program where the degree is earned. Credit used toward degree programs may need to be earned from a particular source or within time constraints (see Senate Policy 83-80 (https://senate.psu.edu/policies-and-rules-for-undergraduate-students/82-00-and-83-00-degree-requirements/#83-80)). For more information, check the Suggested Academic Plan for your intended program.

Program Learning Objectives
1. Knowledge: Understand the technical fundamentals of data sciences with a focus on developing the knowledge and skills needed to manage and analyze data to solve problems in our world.
a. Integrate statistical concepts/methods and computational/machine learning methods to discover the structure of data and build predictive models.
b. Apply the principles of data management to organize and use different types of data, both structured and unstructured.

2. Problem-Solving and Evaluation: Identify, formulate and solve data science problems that arise in various applications.
   a. Identify and incorporate relevant abstraction and domain knowledge to formulate data science problems in different application contexts.
b. Design or adapt appropriate statistical, machine learning, and other data science methods for solving specific problems.
c. Compare, contrast, and evaluate competing data science methods appropriate to the context of the problem.
d. Employ modern computing infrastructure to scale up data science methods for massive and complex data.
e. Integrate data from multiple sources while considering the best practices, challenges, and pitfalls of using heterogeneous data to solve problems.

3. Communication: Articulate the benefits, risks, formulation, solution, and results of data science projects to diverse stakeholders, including fellow data scientists, collaborators with subject matter expertise, and the general public, using written, verbal, and visual forms.

4. Teamwork: Participate effectively on teams in order to accomplish the goals of a project containing data science components.

5. Data Ethics: Critically evaluate and conscientiously respond to the ethical and societal implications of data science practice.
   a. Analyze the potential human impacts of data-driven technologies, especially for marginalized communities.
   b. Develop strategies to solve data science problems that reflect shared social and ethical values, such as privacy, security, fairness, and accountability.
   c. Interpret and apply the ethical responsibilities of computing professionals.
   d. Ensure reproducibility of data science analyses.

6. Lifelong Learning: Recognize the importance of continued learning beyond graduation.
   a. Demonstrate readiness to join an evolving professional community by participating in professional development, such as reading trade journals and engaging with appropriate professional organizations.
   b. Demonstrate readiness for independent learning by performing literature reviews and staying abreast of current trends within the field of data science.

7. Option Objectives:
   a. Applied Data Sciences Option: Gain in-depth knowledge in a chosen application focus area and demonstrate skills to formulate and solve data science problems in the context of applications in that area.
   b. Computational Data Sciences Option: Design, development, and analysis of software (computational solutions) for data science problems.
   c. Statistical Modeling Data Sciences Option: Demonstrate facility with common regression-based inferential modeling techniques including analysis of variance, generalized linear models, multiple regression, and logistic regression, as well as proficiency in basic statistical optimization and simulation techniques.

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**Academic Advising**

The objectives of the university’s academic advising program are to help advisees identify and achieve their academic goals, to promote their intellectual discovery, and to encourage students to take advantage of both in-and out-of class educational opportunities in order that they become self-directed learners and decision makers.

Both advisers and advisees share responsibility for making the advising relationship succeed. By encouraging their advisees to become engaged in their education, to meet their educational goals, and to develop the habit of learning, advisers assume a significant educational role. The advisee’s unit of enrollment will provide each advisee with a primary academic adviser, the information needed to plan the chosen program of study, and referrals to other specialized resources.

READ SENATE POLICY 32-00: ADVISING POLICY (https://senate.psu.edu/policies-and-rules-for-undergraduate-students/32-00-advising-policy/)

**University Park**

**College of Engineering**
CSE Advising
W209 Westgate Building
University Park, PA 16802
cseadvising@ engr.psu.edu

**College of Information Sciences and Technology**
Undergraduate Academic Advising Center
E103 Westgate Building
University Park, PA 16802
814-865-8947
advising@ist.psu.edu

**Eberly College of Science**
Undergraduate Statistics Office
Academic Advising
323 Thomas Building
University Park, PA 16802
814-865-1348
stat-advising@psu.edu

**Suggested Academic Plan**

The suggested academic plan(s) listed on this page are the plan(s) that are in effect during the 2023-24 academic year. To access previous years’ suggested academic plans, please visit the archive (https://bulletins.psu.edu/undergraduate/archive/) to view the appropriate Undergraduate Bulletin edition (Note: the archive only contains suggested academic plans beginning with the 2018-19 edition of the Undergraduate Bulletin).

**Computational Data Sciences Option: Data Sciences, B.S. at University Park Campus**

The course series listed below provides only one of the many possible ways to move through this curriculum. The University may make changes in policies, procedures, educational offerings, and requirements at any time. This plan should be used in conjunction with your degree audit (accessible in LionPATH as either an Academic Requirements or What If report). Please consult with a Penn State academic adviser on a regular basis to develop and refine an academic plan that is appropriate for you.
If you are starting at a campus other than the one this plan is ending at, please refer to: http://advising.engr.psu.edu/degree-requirements/academic-plans-by-major.aspx

### First Year

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<th>Fall</th>
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<td>CMPS 121 or 131 (GQ)*†</td>
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<td>CMPS 122 or 132*†</td>
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<tr>
<td>MATH 140 (GQ)*‡†</td>
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<td>DS 200 or STAT 200*‡</td>
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### Second Year

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<tr>
<td>CMPS 221*</td>
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<td>CMPS 360*</td>
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### Third Year

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### Fourth Year

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</table>

**Total Credits 123**

* Course requires a grade of C or better for the major
† Course requires a grade of C or better for General Education
‡ Course is an Entrance to Major requirement
† Course satisfies General Education and degree requirement

**University Requirements and General Education Notes:**

US and IL are abbreviations used to designate courses that satisfy Cultural Diversity Requirements (United States and International Cultures).

General Education includes Foundations (GWS and GQ), Knowledge Domains (GHW, ON, GA, GH, GS) and Integrative Studies (Inter-domain) requirements. N or Q (Honors) is the suffix at the end of a course number used to help identify an Inter-domain course, but the inter-domain attribute is used to fill audit requirements. Foundations courses (GWS and GQ) require a grade of ‘C’ or better.

All incoming Schreyer Honors College first-year students at University Park will take ENGL 137H/CAS 137H in the fall semester and ENGL 138T/CAS 138T in the spring semester. These courses carry the GWS designation and replace both ENGL 30H and CAS 100. Each course is 3 credits.

**College Notes:**

- **Health and Wellness Elective:** Students who complete the ROTC program may substitute 3 ROTC credits for the GHW requirement.
- **Natural Sciences Elective:** Nine credits of Natural Science (GN) are required. Any GN courses except the following may be used: ASTRO 1, 7N, 10, 11, 120, 140; all BI SC courses; all courses below CHEM 110 (except 3 credits of CHEM 106 may be used); PHYS 250, 251, and any course below PHYS 211; GEOSC 20
- **OPTION A:** CMPEN 454, CMPS 450, CMPS 455, CMPS 456, MATH 484, or MATH 452
- **OPTION B:** CMPEN 431W, EE 456, IST 441, MATH 486, MATH 448, STAT 416, STAT 440, STAT 460, STAT 461, or STAT 462
- **Department List Course (General Elective):** See handbook at eecs.psu.edu (https://www.eecs.psu.edu)

**Career Paths**

Data Sciences blends the technical expertise needed to analyze, interpret, and manage big data with the interpersonal skills needed to communicate insights to a variety of audiences. The program prepares students to meet the growing need for professionals who have the analytical and problem-solving skills to address a wide range of societal challenges. Many companies participate in career fairs in Engineering, IST and Science with an express interest in hiring data science interns or graduates. A growing number of M.S. and Ph.D. programs await those who wish to pursue more advanced studies.

**Careers**

Because our courses blend technical knowledge with skills in communication and business, a Data Sciences degree allows students to compete for leading-edge analytics positions across many different industry sectors. Possible careers include: Data Scientist, Data Analyst, Data Specialist, Data Visualization Specialist, IT Analyst, Machine Learning Engineer, Data Engineer, Business Systems Analyst/Consultant.

**MORE INFORMATION FOR THE APPLIED DATA SCIENCES OPTION** (https://www.ist.psu.edu/current/careers/development/process/path/)

**MORE INFORMATION FOR THE COMPUTATIONAL DATA SCIENCES OPTION** (https://www.eecs.psu.edu/students/undergraduate/Data-Sciences.aspx)

**MORE INFORMATION FOR THE STATISTICAL MODELING DATA SCIENCES OPTION** (https://science.psu.edu/stat/undergraduate-programs/)
Professional Resources

- Association for Computing Machinery (https://acm.psu.edu)
- Association for Information Science and Technology (https://www.asist.org)

Contact

University Park

College of Engineering
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
W209 Westgate Building
University Park, PA 16802
814-865-9505
trk149@psu.edu

https://www.eecs.psu.edu

College of Information Sciences and Technology
COLLEGE OF INFORMATION SCIENCES AND TECHNOLOGY
411 Eric J. Barron Innovation Hub Building
State College, PA 16801
814-865-3528

Eberly College of Science
DEPARTMENT OF STATISTICS
326 Thomas Building
University Park, PA 16802
814-865-1348
stat-advising@psu.edu

https://science.psu.edu/stat/contact-us (https://science.psu.edu/stat/contact-us/)