

Mathematics and Computer Science Major

Program Requirements

- **Total units required:** 51

The McKelvey School of Engineering and the College of Arts & Sciences developed a major that efficiently captures the intersection of the complementary studies of computer science and math.

McKelvey Engineering students who declare this major must fulfill the core course requirements listed below and all other requirements for the Applied Science degree in the McKelvey School of Engineering. They must also complete Engr 310 Technical Writing and 8 units of courses designated as NSM (Natural Sciences & Math) from Anthropology (L48 Anthro), Biology and Biomedical Sciences (L41 Biol), Chemistry (L07 Chem), Earth, Environmental, and Planetary Sciences (L19 EPSc), Physics (L31 Physics) or Environmental Studies (L82 EnSt).

Arts & Sciences students who declare this major must fulfill the distribution requirements and all other requirements for an AB degree in addition to the specific requirements listed below.

Core Course Requirements*

Code	Title	Units
CSE 131	Introduction to Computer Science	3
CSE 240	Logic and Discrete Mathematics	3
CSE 247	Data Structures and Algorithms	3
Math 131	Calculus I (AP credit may satisfy this requirement) **	3
Math 132	Calculus II (AP credit may satisfy this requirement) **	3
Math 233	Calculus III **	3
Math 310 or Math 310W	Foundations for Higher Mathematics Foundations For Higher Mathematics With Writing	3
Math 309	Matrix Algebra	3
SDS 3200 or ESE 326 or SDS 3211	Elementary to Intermediate Statistics and Data Analysis Probability and Statistics for Engineering Statistics for Data Science I	3
CSE 347	Analysis of Algorithms	3
Total Units		30

* Each of these core courses must be passed with a C- or better.

** Students who complete the Math 203 Honors Mathematics I and Math 204 Honors Mathematics II sequence will be considered to have completed Math 131 Calculus I, Math 132 Calculus II, and Math 233 Calculus III. These students can also choose to take additional electives in place of Math 309 Matrix Algebra and Math 310 Foundations for Higher Mathematics.

Electives

Seven upper-level courses from Math or Computer Science & Engineering can be chosen from the approved list, with the following caveats:

- At least three courses must be taken from CSE and at least three courses must be taken from Math.
- At most one preapproved course from outside both departments can be selected.
- CSE 400 Independent Study or CSE 400E Independent Study may be taken for a maximum of 3 units and must be approved by a CS +Math review committee.
- Students may count either Math 456 or ESE 427 as an elective toward the major, but not both. Likewise, students may count either CSE 417T or ESE 417 as an elective toward the major, but not both.

List of Approved Electives Computer Science & Engineering

Code	Title	Units
CSE 217A	Introduction to Data Science	3
CSE 341T	Parallel and Sequential Algorithms	3
CSE 411A	AI and Society	3
CSE 412A	Introduction to Artificial Intelligence	3
CSE 416A	Data Science for Complex Networks	3
CSE 417T	Introduction to Machine Learning	3
CSE 427S	Cloud Computing with Big Data Applications	3
CSE 442T	Introduction to Cryptography	3
CSE 447T	Introduction to Formal Languages and Automata	3
CSE 457A	Introduction to Visualization	3
CSE 468T	Introduction to Quantum Computing	3
CSE 513T	Theory of Artificial Intelligence and Machine Learning	3
CSE 514A	Data Mining	3
CSE 515T	Bayesian Methods in Machine Learning	3
CSE 516A	Multi-Agent Systems	3
CSE 517A	Machine Learning	3
CSE 518A	Human-in-the-Loop Computation	3
CSE 533T	Coding and Information Theory for Data Science	3
CSE 534A	Large-Scale Optimization for Data Science	3
CSE 541T	Advanced Algorithms	3

CSE 543T	Algorithms for Nonlinear Optimization	3
CSE 544T	Special Topics in Computer Science Theory	3
CSE 546T	Computational Geometry	3
CSE 554A	Geometric Computing for Biomedicine	3
CSE 555T	Adversarial AI	3
CSE 559A	Computer Vision	3
CSE 581T	Approximation Algorithms	3
CSE 584A	Algorithms for Biosequence Comparison	3
CSE 587A	Algorithms for Computational Biology	3

Mathematics

Code	Title	Units
Math 350	Topics in Applied Mathematics	3
Math 370	Introduction to Combinatorics	3
Math 371	Graph Theory	3
Math 407	An Introduction to Differential Geometry	3
Math 410	Introduction to Fourier Series and Integrals	3
Math 4111	Introduction to Analysis	3
Math 4121	Introduction to Lebesgue Integration	3
Math 4171	Topology I	3
Math 429	Linear Algebra	3
Math 430	Modern Algebra	3
Math 4351	Number Theory and Cryptography	3
Math 444	The Mathematics of Quantum Theory	3
Math 449	Numerical Applied Mathematics	3
Math 450	Topics in Applied Mathematics	3
Math 456	Topics in Financial Mathematics	3
Math 470	Topics in Graph Theory	3
Math 493C/SDS 493	Probability	3
Math 495C/SDS 495	Stochastic Processes	3

Statistics and Data Science

Code	Title	Units
SDS 420	Experimental Design	3
SDS 434	Survival Analysis	3
SDS 439	Linear Statistical Models	3
SDS 459	Bayesian Statistics	3
SDS 460	Multivariate Statistical Analysis	3
SDS 4601	Statistical Learning	3
SDS 461	Time Series Analysis	3
SDS 462	Mathematical Foundations of Big Data	3
SDS 475	Statistical Computation	3
SDS 493/Math 493C	Probability	3
SDS 494	Mathematical Statistics	3
SDS 495/Math 495C	Stochastic Processes	3

Electrical & Systems Engineering

Code	Title	Units
ESE 4031	Optimization for Engineered Planning, Decisions and Operations	3
ESE 415	Optimization	3
ESE 417	Introduction to Machine Learning and Pattern Classification	3
ESE 427	Financial Mathematics	3
ESE 429	Basic Principles of Quantum Optics and Quantum Information	3
ESE 520	Probability and Stochastic Processes	3

Economics

Code	Title	Units
Econ 4151	Applied Econometrics	3
Econ 467	Game Theory	3

Linguistics

Code	Title	Units
Ling 317	Introduction to Computational Linguistics	3
Ling 427	Computation and Learnability in Linguistic Theory	3

Biology and Biomedical Sciences

Code	Title	Units
Biol 5657	Biological Neural Computation	3

Biomedical Engineering

Code	Title	Units
BME 470	Mathematics of Imaging Science	3

Additional Information

1. A student cannot declare more than one major or minor in the Department of Mathematics. This restriction includes dual majors, such as Mathematics and Economics and Mathematics and Computer Science. These majors are considered "in the department" even if they are declared in another department.
2. No **upper-level** course used to satisfy a major requirement can be counted toward the requirements of any other major or minor (i.e., no double-counting of courses).
3. At most 3 units of independent study or research work can count toward the major requirements.
4. Students may count courses from the Department of Statistics and Data Science (SDS) as Mathematics courses if at least one of the following conditions holds:
 - a. The course is cross-listed in the Department of Mathematics (e.g., Math 493C and Math 495C are cross-listed versions of SDS 493 and SDS 495).
 - b. The student matriculated in 2023-2024 or earlier, and the course was previously offered by the Department of Mathematics and Statistics, as reflected by the student's matriculation-year Bulletin.

5. At most one of the following courses can be used to fulfill major requirements: Math 308 Mathematics for the Physical Sciences or Math 318 Introduction to Calculus of Several Variables.
6. Courses transferred from other accredited colleges and universities can be counted, with the following caveats, if they receive department approval:
 - a. Courses transferred from a two-year college (e.g., a community college) cannot be used to satisfy upper-level requirements.
 - b. At least half of the upper-level units required in a major must be earned at Washington University or in a Washington University-approved overseas study program.
 - c. Courses from the School of Continuing & Professional Studies cannot be used to fulfill major requirements.

Latin Honors

At the time of graduation, the Department of Mathematics will recommend that a candidate receive Latin Honors (cum laude, magna cum laude, or summa cum laude) if that student has completed the department's requirements for High Distinction or Highest Distinction in Mathematics, including an Honors Thesis. The actual award of Latin Honors is managed by the College of Arts & Sciences.

The Honors Thesis

Arts & Sciences mathematics majors who want to be candidates for Latin Honors, High Distinction, or Highest Distinction must complete an honors thesis. Writing an honors thesis involves a considerable amount of independent work, reading, creating mathematics, writing a paper that meets acceptable professional standards, and making an oral presentation of the results.

Types of Projects

An honors thesis can take two forms:

1. A thesis that presents significant work by the student on one or more nontrivial mathematics problems.
2. A substantial expository paper that follows independent study on an advanced topic under the guidance of a department faculty member. Such a report would involve the careful presentation of ideas and the synthesis of materials from several sources.

Process and Suggested Timeline

Junior Year, Spring Semester:

1. Talk with a faculty advisor about possible projects.
2. Complete the Honors Proposal Form and submit it to Blake Thornton.

Senior Year:

1. By the end of January, provide the advisor with a draft abstract and outline of the paper.
2. By the end of February, submit a rough draft, including an abstract, to the advisor.
3. The student and the advisor should agree on a date that the writing will be complete and on a date and time for the oral presentation in mid-March (the deadline is March 31).

Departmental Prizes

Each year, the department considers graduating majors for three departmental prizes and also awards a prize to juniors. Recipients are recognized at an annual awards ceremony in April where graduating majors each receive a certificate and a set of honors cords to be worn as part of the academic dress at Commencement. Awards are noted on the student's permanent university record.

Ross Middlemiss Prize

The Ross Middlemiss Prize is awarded to a graduating math major with an outstanding record. The award was established by former Professor Ross Middlemiss, who taught at Washington University for 40 years. Middlemiss authored several books, including a widely popular calculus text that was used in courses offered by the School of Continuing & Professional Studies until the late 1970s.

Putnam Exam Prize

The Putnam Exam Prize is awarded to a graduating senior who has participated regularly in the Putnam Exam Competition and done exceptionally well throughout their time at Washington University.

Martin Silverstein Award

The Martin Silverstein Award was established in memory of Professor Martin Silverstein, who, until his death in 2004, was a pioneer in work at the interface of probability theory and harmonic analysis. Graduating students completing any major we offer will be considered for this award, but preference is given to those who have done excellent work in applied mathematics or analysis.

Brian Blank Award

The Brian Blank Award was established in memory of Professor Brian Blank, who passed away in 2018. Each year, the Department of Mathematics selects distinguished juniors majoring in mathematics for this prize.

Distinctions in Mathematics and Computer Science

Distinction

- For Distinction in Mathematics and Computer Science, a student must take an additional two electives for a total of nine electives.
- The student's GPA in the nine electives must be at least 3.7. If the student takes additional courses that satisfy these requirements, the courses with the lowest grades may be omitted when calculating the GPA for this purpose.

- The student must complete at least four courses from the list of approved courses, each with a grade of B or better. These courses can be in either department (i.e., Mathematics or Computer Science & Engineering) and must be classroom courses, not independent study. The list of courses will be maintained by both departments. Current approved courses include the following:

Code	Title	Units
Math 4111	Introduction to Analysis	3
Math 4121	Introduction to Lebesgue Integration	3
Math 4171	Topology I	3
Math 4181	Topology II	3
Math 429	Linear Algebra	3
Math 430	Modern Algebra	3
Math 4351	Number Theory and Cryptography	3
Math 449	Numerical Applied Mathematics	3
Math 450	Topics in Applied Mathematics	3
Math 456	Topics in Financial Mathematics	3
Math 470	Topics in Graph Theory	3
CSE 411A	AI and Society	3
CSE 416A	Data Science for Complex Networks	3
CSE 417T	Introduction to Machine Learning	3
CSE 427S	Cloud Computing with Big Data Applications	3
CSE 442T	Introduction to Cryptography	3
CSE 447T	Introduction to Formal Languages and Automata	3
CSE 468T	Introduction to Quantum Computing	3
CSE 513T	Theory of Artificial Intelligence and Machine Learning	3
CSE 514A	Data Mining	3
CSE 515T	Bayesian Methods in Machine Learning	3
CSE 516A	Multi-Agent Systems	3
CSE 517A	Machine Learning	3
CSE 518A	Human-in-the-Loop Computation	3
CSE 541T	Advanced Algorithms	3
CSE 543T	Algorithms for Nonlinear Optimization	3
CSE 544T	Special Topics in Computer Science Theory	3
CSE 546T	Computational Geometry	3
CSE 554A	Geometric Computing for Biomedicine	3
CSE 581T	Approximation Algorithms	3
CSE 587A	Algorithms for Computational Biology	3

High Distinction

- Complete all requirements for Distinction.
- Complete an honors thesis in either department (Mathematics or Computer Science & Engineering).

Highest Distinction

- Complete the requirements for High Distinction.
- Complete one of the two options described below:
 - **Qualifier Option:** Complete two semesters of graduate course work and qualifier exams in the Department of Mathematics as described above for Highest Distinction for mathematics majors.
 - **Course Option:** Complete three additional electives for a total of 12 courses. As with Distinction, the student's GPA in the 12 electives must be at least 3.7, and additional courses beyond 12 can be disregarded when calculating the GPA. The 12 electives must include at least eight courses selected from the list under Distinction, with the student earning a grade of B+ or better in each course. At least two of these eight courses must be from each department (Mathematics and Computer Science & Engineering).

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