# Bachelor of Science in Mathematics

## Why study mathematics?

Because mathematics is a framework upon which humanity builds an understanding of the world.

The degree of Bachelor of Science in Mathematics offers more extensive training in mathematics and its applications than is possible in the B.A. curriculum. The requirements for the B.S. in Mathematics allow a great deal of flexibility in choice of courses and concentrations. Students should plan their programs carefully to meet individual interests and goals, and carefully check the prerequisites for all courses in their programs.

Many students have strong interests in particular areas of mathematics. The Department has created three informal tracks within the B.S. program: a statistics track, an applied mathematics track, and a track in pure mathematics. These tracks are advisory only. Students without strong interests in one of these areas are encouraged to put together a broad program within the B.S. Degree.

## Undergraduate Admission

### Admission to KU

All students applying for admission must send high school and college transcripts to the Office of Admissions. Prospective first-year students should be aware that KU has qualified admission requirements that all new first-year students must meet to be admitted. Consult the Office of Admissions (http://admissions.ku.edu/) for application deadlines and specific admission requirements.

Visit the International Support Services (http://www.iss.ku.edu/) for information about international admissions.

Students considering transferring to KU may see how their college-level course work will transfer on the Office of the University Registrar (https://registrar.ku.edu/credittransfer/) website.

## Mathematics Programs

Separate programs lead to the B.A. in mathematics and the B.S. in mathematics. The B.A. has fewer mathematics course requirements and more general education requirements. The B.S. requires more mathematics courses, three courses in mathematics applications, and fewer general education courses. Students wishing to attend graduate school in mathematics or to pursue a career that makes substantial use of mathematics (as an actuary, for example) should get a B.S. in mathematics. Many students majoring in mathematics are interested in a liberal arts degree; such students may want to consider the B.A. in mathematics. Students who wish to teach mathematics in high school should pursue a B.A. or B.S. in mathematics while participating in the UKanTeach program (http://ukanteach.ku.edu/).

## Requirements for the B.S. Degree

| Code | Title | Hours |
|---|---|---|
| **First- and Second-Year Preparation** | | |
| MATH 125 | Calculus I | 4 |
| or MATH 145 | Calculus I, Honors | |
| MATH 126 | Calculus II | 4 |
| or MATH 146 | Calculus II, Honors | |
| MATH 127 | Calculus III | 4 |
| or MATH 147 | Calculus III, Honors | |
| MATH 290 | Elementary Linear Algebra | 2 |
| or MATH 291 | Elementary Linear Algebra, Honors | |
| Select one of the following: | | 3 |
| MATH 320 | Elementary Differential Equations | |
| MATH 220 | Applied Differential Equations | |
| MATH 221 | Applied Differential Equations, Honors | |
| **Core Requirements** | | |
| MATH 590 | Linear Algebra | 3 |
| or MATH 790 | Linear Algebra II | |
| MATH 500 | Intermediate Analysis | 3 |
| or MATH 765 | Mathematical Analysis I | |
| MATH 558 | Introductory Modern Algebra | 3 |
| or MATH 791 | Modern Algebra | |
| Select one of the following: | | 3 |
| MATH 526 | Applied Mathematical Statistics I | |
| MATH 628 | Mathematical Theory of Statistics | |
| MATH 728 | Statistical Theory | |
| **Mathematics Sequence and Electives Requirement** | | **12** |
| Mathematics Sequence: Select one 2-course sequence from List A and a second 2-course sequence from either List A or List B | | |
| Mathematics Electives: Select up to 2 additional 3-credit-hour courses to complete a total of 24 credit hours of mathematics courses numbered MATH 450 and above. | | |
| **Capstone Course** | | |
| MATH 699 | Directed Reading | 1 |
| **Mathematics Application Requirement** | | |
| 3 courses, totaling at least 8 credit hours, that make significant use of mathematics. At least 2 courses must be in the same area. Courses from List C have been approved for this requirement. Other upper-division courses making significant use of mathematics can be used for the mathematics application requirement with the approval of a mathematics department advisor. | | 8 |
| **Total Hours** | | **50** |

**Note:** Many of these courses have prerequisites that do not count toward the mathematics major.

## Minimum Major Requirements

50 hours

**General Education Requirements:** 46-50 hours (Actual credit hours may be less because of overlap of Core Curriculum and degree-specific requirements.)

### Completion of the University Core Curriculum

| Code | Title | Hours |
|---|---|---|
| **Writing** | | |
| ENGL 101 | Composition (or exemption) | 3 |
| Select one of the following: | | 3 |
| ENGL 102 | Critical Reading and Writing (or exemption) | |
| ENGL 105 | Honors Introduction to English (or exemption) | |

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|---|---|---|
| **Computer Science** | | |
| Select one of the following: | | 3-4 |
| EECS 138 | Introduction to Computing: _____ | |
| EECS 168 | Programming I | |
| EECS 169 | Programming I: Honors | |
| **Natural Science** | | |
| Select one course with laboratory | | 4-5 |
| Select one additional course in a natural science other than mathematics | | 3-5 |

## List A Sequences

| Code | Title | Hours |
|---|---|---|
| MATH 627<br>& MATH 628 | Probability<br>and Mathematical Theory of Statistics | 6 |
| MATH 660<br>& MATH 661 | Geometry I<br>and Geometry II | 6 |
| MATH 727<br>& MATH 728 | Probability Theory<br>and Statistical Theory | 6 |
| MATH 765<br>& MATH 766 | Mathematical Analysis I<br>and Mathematical Analysis II | 6 |
| MATH 781<br>& MATH 782 | Numerical Analysis I<br>and Numerical Analysis II | 6 |
| MATH 790<br>& MATH 791 | Linear Algebra II<br>and Modern Algebra | 6 |

## List B Sequences

| Code | Title | Hours |
|---|---|---|
| MATH 500<br>& MATH 646 | Intermediate Analysis<br>and Complex Variable and Applications | 6 |
| MATH 526<br>& MATH 605 | Applied Mathematical Statistics I<br>and Applied Regression Analysis | 6 |
| MATH 526<br>& MATH 611 | Applied Mathematical Statistics I<br>and Time Series Analysis | 6 |
| MATH 540<br>& MATH 558 | Elementary Number Theory<br>and Introductory Modern Algebra | 6 |
| MATH 558<br>& MATH 601 | Introductory Modern Algebra<br>and Algebraic Topics in Computing: _____ | 6 |
| MATH 540<br>& MATH 791 | Elementary Number Theory<br>and Modern Algebra | 6 |
| MATH 581<br>& MATH 591 | Numerical Methods<br>and Applied Numerical Linear Algebra | 6 |
| MATH 581<br>& MATH 582 | Numerical Methods<br>and Computational Data Science | 6 |
| MATH 590<br>& MATH 591 | Linear Algebra<br>and Applied Numerical Linear Algebra | 6 |
| MATH 590<br>& MATH 790 | Linear Algebra<br>and Linear Algebra II | 6 |
| MATH 601<br>& MATH 791 | Algebraic Topics in Computing: _____<br>and Modern Algebra | 6 |
| MATH 605<br>& MATH 608 | Applied Regression Analysis<br>and Statistical Data Science | 6 |
| MATH 605<br>& MATH 611 | Applied Regression Analysis<br>and Time Series Analysis | 6 |
| MATH 646<br>& MATH 647 | Complex Variable and Applications<br>and Applied Partial Differential Equations | 6 |
| MATH 646<br>& MATH 765 | Complex Variable and Applications<br>and Mathematical Analysis I | 6 |
| MATH 647<br>& MATH 648 | Applied Partial Differential Equations<br>and Calculus of Variations and Integral Equations | 6 |
| MATH 647<br>& MATH 650 | Applied Partial Differential Equations<br>and Nonlinear Dynamical Systems | 6 |
| MATH 648<br>& MATH 650 | Calculus of Variations and Integral Equations<br>and Nonlinear Dynamical Systems | 6 |
| MATH 724<br>& MATH 725 | Combinatorial Mathematics<br>and Graph Theory | 6 |
| MATH 582<br>& MATH 608 | Computational Data Science<br>and Statistical Data Science | 6 |
| MATH 582<br>& MATH 591 | Computational Data Science<br>and Applied Numerical Linear Algebra | 6 |
| MATH 608<br>& MATH 611 | Statistical Data Science<br>and Time Series Analysis | 6 |

## List C Mathematics Applications

| Code | Title | Hours |
|---|---|---|
| **Statistics and Data Science** | | |
| MATH 582 | Computational Data Science | 3 |
| MATH 605 | Applied Regression Analysis | 3 |
| MATH 608 | Statistical Data Science | 3 |
| MATH 611 | Time Series Analysis | 3 |
| MATH 624 | Discrete Probability | 3 |
| GEOL 504 | Inverse Problems for Geoscientists | 3 |
| GEOG 716 | Advanced Geostatistics | 3 |
| **Economics and Finance** | | |
| ECON 490 | Game Theory | 3 |
| ECON 526 | Introduction to Econometrics | 3 |
| ECON 620 | Elements of Mathematical Economics | 3 |
| ECON 669 | The Economics of Financial Markets | 3 |
| ECON 700 | Survey of Microeconomics | 3 |
| ECON 701 | Survey of Macroeconomics | 3 |
| ECON 715 | Elementary Econometrics | 3 |
| ECON 716 | Econometric Forecasting | 3 |
| ECON 790 | Game Theory and Applications | 3 |
| ECON 791 | Game Theory and Applications II | 3 |
| ECON 817 | Econometrics I | 3 |
| ECON 818 | Econometrics II | 3 |
| FIN 310 | Finance | 3 |
| or FIN 311 | Finance, Honors | |
| FIN 410 | Investment Theory and Applications | 3 |
| or FIN 411 | Investment Theory and Applications, Honors | |
| FIN 415 | Corporate Finance | 3 |
| FIN 420 | International Finance | 3 |
| or FIN 421 | International Finance, Honors | |
| FIN 425 | Futures and Options | 3 |
| MATH 630 | Actuarial Mathematics | 3 |
| SCM 310 | Management Science and Operations Management | 3 |
| or SCM 311 | Management Science and Operations Management, Honors | |
| BSAN/SCM 415 | Data Analysis and Forecasting * | 3 |

| | | |
|---|---|---|
| BSAN 450 | Data Mining and Predictive Analytics * | 3 |
| **Biology** | | |
| BIOL 350 | Principles of Genetics | 4 |
| or BIOL 360 | Principles of Genetics, Honors | |
| BIOL 370 | Introduction to Biostatistics * | 4 |
| BIOL 412 | Evolutionary Biology | 4 |
| BINF 701 | Computational Biology I | 5 |
| BINF 702 | Computational Biology II | 5 |
| BIOL 743 | Population Genetics | 3 |
| **Physics and Astronomy** | | |
| PHSX 313 | General Physics III | 3 |
| PHSX 315 | Introduction to Computation for Physics and Astronomy | 3 |
| PHSX 518 | Mathematical Physics | 3 |
| or EPHX 518 | Mathematical Physics | |
| PHSX 521 | Mechanics I | 3 |
| or EPHX 521 | Mechanics I | |
| PHSX 531 | Electricity and Magnetism | 3 |
| or EPHX 531 | Electricity and Magnetism | |
| ASTR 591 | Stellar Astronomy | 3 |
| ASTR 592 | Galactic and Extragalactic Astronomy | 3 |
| PHSX 611 | Introductory Quantum Mechanics | 3 |
| or EPHX 611 | Introductory Quantum Mechanics | |
| PHSX/EPHX 616 | Physical Measurements * | 4 |
| PHSX 615 | Numerical and Computational Methods in Physics | 3 |
| or EPHX 615 | Numerical and Computational Methods in Physics | |
| PHSX 621 | Mechanics II | 3 |
| or EPHX 621 | Mechanics II | |
| PHSX 631 | Electromagnetic Theory | 3 |
| or EPHX 631 | Electromagnetic Theory | |
| PHSX 671 | Thermal Physics | 3 |
| or EPHX 671 | Thermal Physics | |
| PHSX 691 | Astrophysics I | 3 |
| or ASTR 691 | Astrophysics I | |
| or EPHX 691 | Astrophysics I | |
| PHSX 711 | Quantum Mechanics I | 3 |
| PHSX 741 | Nuclear Physics I | 3 |
| **Chemistry** | | |
| CHEM 400 | Analytical Chemistry | 3 |
| CHEM 510 & CHEM 511 | Biological Physical Chemistry and Biological Physical Chemistry Laboratory | 5 |
| CHEM 525 | Physical Chemistry for Engineers | 4 |
| CHEM 530 | Physical Chemistry I | 4 |
| CHEM 535 | Physical Chemistry II | 3 |
| CHEM 750 | Introduction to Quantum Mechanics | 3 |
| **Atmospheric Science** | | |
| ATMO 630 | Synoptic Meteorology | 3 |
| ATMO 640 | Dynamic Meteorology | 3 |
| ATMO 642 | Remote Sensing | 3 |
| ATMO 650 | Advanced Synoptic Meteorology | 3 |
| ATMO 660 | Advanced Dynamic Meteorology | 3 |
| ATMO 680 | Physical Meteorology | 3 |
| **Aerospace Engineering** | | |
| AE 345 | Fluid Mechanics | 3 |
| AE 445 | Aircraft Aerodynamics and Performance | 3 |
| AE 506 | Aerospace Structures I, Honors | 3 |
| or AE 507 | Aerospace Structures I | |
| AE 508 | Aerospace Structures II | 3 |
| or AE 509 | Honors Aerospace Structures II | |
| AE 545 | Fundamentals of Aerodynamics | 3 |
| or AE 546 | Aerodynamics, Honors | |
| AE 550 | Dynamics of Flight I | 3 |
| AE 551 | Dynamics of Flight II | 3 |
| or AE 552 | Honors Dynamics of Flight II | |
| AE 725 | Numerical Optimization and Structural Design | 3 |
| AE 750 | Applied Optimal Control | 3 |
| **Chemical and Petroleum Engineering** | | |
| C&PE 211 | Material and Energy Balances | 3 |
| C&PE 221 | Chemical Engineering Thermodynamics I | 3 |
| C&PE 511 | Momentum Transfer | 3 |
| C&PE 512 | Chemical Engineering Thermodynamics II | 3 |
| C&PE 525 | Heat and Mass Transfer | 4 |
| C&PE 678 | Applied Optimization Methods | 3 |
| C&PE 778 | Applied Optimization Methods | 3 |
| **Civil Engineering** | | |
| CE 201 | Statics | 2 |
| CE 250 | Dynamics | 3 |
| CE 260 | Statics and Dynamics | 5 |
| CE 310 | Strength of Materials | 3 |
| or CE 312 | Strength of Materials, Honors | |
| CE 330 | Fluid Mechanics | 3 |
| CE 461 | Structural Analysis | 3 |
| CE 704 | Dynamics and Vibrations | 3 |
| or AE 704 | Dynamics and Vibrations | |
| **Electrical Engineering and Computer Science** | | |
| EECS 212 | Circuits II | 4 |
| EECS 330 | Data Structures and Algorithms | 4 |
| EECS 361 | Signal and System Analysis | 3 |
| EECS 420 | Electromagnetics II | 4 |
| EECS 444 | Control Systems | 3 |
| EECS 510 | Introduction to the Theory of Computing | 3 |
| EECS 562 | Introduction to Communication Systems | 4 |
| EECS 563 | Introduction to Communication Networks * | 3 |
| EECS 630 | Advanced Data Structures and Algorithms | 3 |
| EECS 644 | Introduction to Digital Signal Processing | 3 |
| EECS 649 | Introduction to Artificial Intelligence | 3 |
| EECS 658 | Introduction to Machine Learning | 3 |
| EECS 662 | Programming Languages | 3 |
| EECS 730 | Introduction to Bioinformatics | 3 |
| EECS 739 | Parallel Scientific Computing | 3 |
| EECS 744 | Digital Signal Processing Implementation in Programmable Logic Devices | 3 |
| EECS 769 | Information Theory * | 3 |
| **Mechanical Engineering** | | |

| | | |
|---|---|---|
| ME 211 | Statics and Introduction to Mechanics | 3 |
| ME 212 | Basic Engineering Thermodynamics | 3 |
| ME 311 | Mechanics of Materials | 3 |
| ME 320 | Dynamics | 3 |
| ME 508 | Numerical Analysis of Mechanical Engineering Problems | 3 |
| ME 510 | Fluid Mechanics | 3 |
| ME 612 | Heat Transfer | 3 |
| ME 661 | The Finite Element Method | 3 |
| ME 682 | System Dynamics and Control Systems | 3 |
| ME 788 | Optimal Estimation | 3 |
| **Curriculum & Instruction** | | |
| C&T 360 | Knowing and Learning in Mathematics and Science | 3 |
| C&T 366 | Classroom Interactions in Mathematics and Science | 3 |
| C&T 460 | Project Based Instruction in Mathematics and Science | 3 |
| **Philosophy** | | |
| PHIL 610 | Metalogic | 3 |
| PHIL 630 | Philosophy of Mathematics | 3 |

**Notes:** A student using at least 2 statistics courses for the mathematics application requirement must complete MATH 627 and MATH 628 (or MATH 727 and MATH 728) as a List A sequence. (MATH 627, MATH 628, MATH 727, and MATH 728 do not count for the mathematics application requirement.) A student using at least 2 curriculum & instruction courses for the mathematics application requirement must complete PHSX 211 as one of the natural science courses and must complete at least 1 of the geometry courses MATH 559, MATH 660, or MATH 661.

*Can be counted as a statistics and data science course.

Courses used to satisfy the core requirements can also be used to complete List A and List B sequences. However, no course can be used for 2 List A or B sequences, and courses used for the mathematics application requirement cannot also be counted toward the 24 credit hours of advanced mathematics courses for the B.S. degree.

Some courses satisfying the sequence requirements are taught infrequently. More advanced courses can be substituted for lower level courses in many cases. Consult the mathematics department for expected course offerings and substitutions.

Below is a sample 4-year plan for students pursuing the BS in Mathematics. To view the list of courses approved to fulfill Core 34, please visit the KU Core 34 page (https://catalog.ku.edu/core34/).

This degree plan assumes students will have the equivalent of MATH 104 prior to the freshman year, fall semester.

**Freshman**

| Fall | Hours | Spring | Hours |
|---|---|---|---|
| Core 34: English (SGE)[010] | 3 | Core 34: English (SGE)[010] | 3 |
| Core 34: Social and Behavior Science (SGE)[050] | 3 | Core 34: Communications (SGE)[020] | 3 |
| Core 34: Natural and Physical Sciences (SGE)[040] | 4-5 | EECS 138, 168, or 169 (BS Requirement) | 3 |
| MATH 125 (Core 34: Math and Statistics (SGE))[030*] | 4 | MATH 126 (Major Requirement) | 4 |
| | | Second Area of Study/ Elective/Degree/Junior-Senior Hours[6] | 3 |
| | **14-15** | | **16** |

**Sophomore**

| Fall | Hours | Spring | Hours |
|---|---|---|---|
| Core 34: Arts and Humanities (SGE)[060] | 3 | Core 34: Social and Behavior Science (SGE)[050] | 3 |
| Addtional Natural Science (BS Requirement) | 3 | MATH 320, 220, or 221 (Major Requirement) | 3 |
| MATH 127 (Major Requirement) | 4 | Core 34: US Culture (SGE)[070] | 3 |
| MATH 290 or 291 (Major Requirement) | 2 | MATH 590 (Major Requirement) | 3 |
| Pre-requisite for Math Application Course or Second Area of Study/ Elective/Degree/Junior-Senior Hours[4, 6] | 3 | Pre-requisite for Math Application Course or Second Area of Study/ Elective/Degree/Junior-Senior Hours[4, 6] | 3 |
| | **15** | | **15** |

**Junior**

| Fall | Hours | Spring | Hours |
|---|---|---|---|
| Core 34: Global Culture (SGE)[070] | 3 | MATH 500 (Major Requirement) | 3 |
| MATH 558 (Major Requirement) | 3 | Math Sequence Course 500+ (Major Requirement)[1,5] | 3 |
| Math Sequence Course 500+ (Major Requirement)[1] | 3 | Math Application Course (Major Requirement)[3] | 3 |
| Math Application Course (Major Requirement)[3] | 3 | Core 34: Arts and Humanities (SGE)[060] | 3 |
| Second Area of Study/ Elective/Degree/Junior-Senior Hours[6] | 3 | Second Area of Study/ Elective/Degree/Junior-Senior Hours[6] | 3 |
| | **15** | | **15** |

**Senior**

| Fall | Hours | Spring | Hours |
|---|---|---|---|
| Math Sequence Course 500+ (Major Requirement)[1] | 3 | MATH 699 (Capstone) | 1 |
| Math Application Course (Major Requirement)[3] | 3 | Math Sequence Course 500+ (Capstone/Major Requirement)[1] | 3 |
| Math Elective 450+ (Major Requirement)[2, 5] | 3 | Math Elective 450+ (Math Requirement)[2,5] | 3 |
| Second Area of Study/ Elective/Degree/Junior-Senior Hours[6] | 3 | Second Area of Study/ Elective/Degree/Junior-Senior Hours[6] | 3 |
| Second Area of Study/ Elective/Degree/Junior-Senior Hours[6] | 3 | Second Area of Study/ Elective/Degree/Junior-Senior Hours[6] | 3 |

| | | |
|---|---|---|
| | Second Area of Study/ Elective/Degree/Junior-Senior Hours[6] | 2 |
| | **15** | **15** |

**Total Hours 120-121**

1. Students are required to select one 2-course sequence from List A and a second 2-course sequence from either List A or List B. Refer to Degree Requirements tab for lists of courses and the department's website for course frequency: https://mathematics.ku.edu/frequency-courses (https://mathematics.ku.edu/frequency-courses/).
2. Select up to 2 additional 3-credit-hour courses to complete a total of 24 credit hours of mathematics courses numbered MATH 450 and above if needed. Students are required to complete a total of 24 credit hours of mathematics courses numbered MATH 450 and above. 12 of the 24 hours are completed through the Math Core Requirements: MATH 590, MATH 526 (or MATH 628 or MATH 728), MATH 500 and MATH 558.
3. The Mathematics Application Requirements consist of 3 courses, totaling at least 8 credit hours, that make significant use of mathematics. At least 2 courses must be in the same area. Courses from List C have been approved for this requirement. Refer to the Degree Requirements tab for a list of courses that can fulfill this major requirement.
4. Most courses that count for the Mathematics Application Requirements have one or more pre-requisites that may or may not apply to other degree requirements.
5. Students using MATH 627-MATH 628 as their List A sequence need not take MATH 526; MATH 526 is required for those not taking MATH 628 or MATH 728.
6. Hour requirements (incl. 45 jr/sr hrs) are typically met through Core 34, degree, major, second area of study and/or elective hours. Students completing the BGS with a major must choose a secondary area of study. Individual degree mapping is done in partnership with your advisor.

Please note:

All students in the College of Liberal Arts and Sciences are required to complete 120 total hours of which 45 hours must be at the Jr/Sr (300+) level.

**Notes:**

* - This course is a Required major course and is also part of Core 34: Systemwide General Education. If this course is not taken to fulfill the Core 34:SGE requirement, it must be taken in place of elective hours.

** - This course is a Recommended Core 34: Systemwide General Education course. This specific course is not required but is recommended by the program's faculty.

*** - This course is a Required Core 34: Systemwide General Education course. This program is approved by the Kansas Board of Regents to require this specific Core 34:Systemwide General Education course. If a student did not take this course it must be taken in addition to other degree requirements.

At the completion of this program, students will be able to:

- Interpret and solve problems using symbolic equations and inequities, as well as numerical and graphical data.
- Read and construct rigorous mathematical arguments and proofs.
- Know concepts and be able to use techniques from a variety of mathematical disciplines.

## Departmental Honors

For undergraduate departmental honors, the student must satisfy the College requirements for honors, attain a grade-point average of 3.5 in all mathematics courses numbered 500 and above. The student must also complete two out of the following four sequences: MATH 727 and MATH 728; MATH 765 and MATH 766; MATH 781 and MATH 782; and MATH 790 and MATH 791, with a grade no lower than B- in each of these courses. The student must make a satisfactory oral presentation to the department, preferably on a topic related to his or her mathematics course work. Preparation should include enrollment in MATH 699 Directed Reading (for 1 or more credit hours) with a faculty mentor.

Students interested in graduating with departmental honors are strongly urged to inform the Associate Chair or the Chair of the departmental Honors Committee of their intention as soon as possible. Ideally, this should happen by the end of the sophomore year to ensure sufficient time to complete all the requirements.