MATHEMATICS B.S.MSC.

All students must meet the University Requirements.

MATHEMATICS MAJOR

The mathematics curriculum is quite flexible. It is designed to provide a sound basic training in mathematics that allows a student to experience the broad sweep of mathematical ideas and techniques, to utilize the computer in mathematics, and to develop an area of special interest in the mathematical sciences.

A Bachelor of Arts with a major in mathematics is offered and supervised by the College of Arts and Sciences (CAS). Students opting for this degree require an advisor from the Department of Mathematics and Statistics. Refer to the CAS section of this catalogue for more information.

Concentrations that provide suggested preparation for a student's career plans are listed in the next section, along with the courses recommended for each concentration.

REGULATIONS

Students pursuing the Bachelor of Science in Mathematical Sciences (Majoring in Mathematics) or the Bachelor of Science degree with a major in Data Science are subject to the Academic Standards in CEMS outlined in this catalogue.

Additional Regulations

No more than three grades of D, D+, or D– in 200 level (or higher) mathematics (MATH) or statistics (STAT) courses may be used to satisfy "Core Curriculum" and "Major Courses" requirements.

REQUIREMENTS

A minimum of 120 credits is required. Students must satisfy all University requirements.

A. CORE CURRICULUM

MATH 021	QR: Calculus I [1]	4
MATH 022	QR: Calculus II	4
MATH 052	QR:Fundamentals of Mathematics	3
MATH 121	QR: Calculus III	4
MATH 122	QR: Applied Linear Algebra	3
or MATH 124	QR: Linear Algebra	
MATH 241	QR:Anyl in Several Real Vars I	3
MATH 251	QR: Abstract Algebra I	3
CS 021	QR: Computer Programming I	3

[1] A student with a MATH 021 waiver can use it to fulfill the requirement of MATH 021 in the Core Curriculum. However, at least three extra credits of mathematics numbered above MATH 023 must be added to the Major Courses requirement.

B. MAJOR COURSES

A minimum of twenty-one additional credits in mathematics, statistics, or computer science courses numbered 100 or above. At least twelve credits must be in courses numbered 200 or above and no more than twelve credits can be taken in computer science.

In consultation with their advisor, students should choose an area of interest within the mathematics major and plan a coherent program that addresses their interests in mathematics and its applications. This area might be one of those listed in the Recommendations for Major Courses section below, or it might be another area suggested by the student.

C. ALLIED FIELD COURSES

Twenty-four credits selected from the following Allied Fields:

1. Physical Sciences
2. Biological Sciences
3. Medical Sciences
4. Engineering
5. Computer Science (CS 110 or higher)
6. Agricultural Sciences
7. Business Administration
8. Psychology
9. Economics
10. Environmental Sciences/Studies
11. Natural Resources

Students, in consultation with their advisors, must plan a sequence of Allied Field courses consistent with their professional and personal goals. Students interested in pursuing intensive studies in an area not specifically listed are encouraged to plan a program with their advisor and submit it to the appropriate departmental committee for review and approval. The requirements are as follows:

Twenty-four credits selected from the above list of Allied Fields, including at least one laboratory experience in science or engineering. Of these twenty-four credits, at least six must be in courses numbered 100 or above, and at least six must be taken in fields 1 to 5. Courses used to satisfy requirement B above may not be used to satisfy this requirement.

D. HUMANITIES AND SOCIAL SCIENCE COURSES

(Courses used to satisfy requirement C above may not be used to satisfy this requirement.)

Twenty-four credits of courses selected from categories I, II, and III listed below. These twenty-four credits must be distributed over at least two categories, and at least six credits must be taken in each of the two categories chosen.

Category I: Language and Literature

American Sign Language (ASL); Arabic (ARBC); Chinese (CHIN); Classics (CLAS); English (ENGS); English for Speakers of Other Languages (ESOL); Foreign Language (LANG); French (FREN); German (GERM); Greek (GRK); Hebrew (HEBR); Italian (ITAL); Japanese (JAPN); Latin (LAT); Linguistics (LING); Portuguese (PORT); Russian (RUSS); Spanish (SPAN); World Literature (WLIT).

Category II: Humanities and Fine Arts

Art History (ARTH); Art Studio (ARTS); Dance (DNCE); Film & Television Studies (FTS); Humanities (HUMN); Music (MU); Philosophy (PHIL); Religion (REL); Speech (SPCH); Theatre (THE).

Category III: Social Sciences

Anthropology (ANTH); Communication Sciences & Disorders (CSD); Community Development & Applied Economics (CDAE); Critical Race & Ethnic Studies (CRES); Economics (EC); Environmental Studies (ENVS); Gender, Sexuality & Women's Studies (GSWS); Geography (GEOG); Global & Regional Studies (GRS); History (HST); Holocaust Studies (HS); Human Development & Family Studies (HDFS); Political Science (POLS); Psychological Science (PSYS); Sociology (SOC); Vermont Studies (VS).

RECOMMENDATIONS FOR MAJOR COURSES

As a guide, students interested in one of the specialization areas would typically take at least three courses in that area, including all of the courses marked with an asterisk (*). In addition, students should take courses from at least two other areas. Because of its centrality in mathematics, students are advised to take at least one course listed under Classical Mathematics. In following these recommendations, a course listed in more than one area is meant to be counted only once.

1. Classical Mathematics

Classical mathematics encompasses those areas having their roots in the great traditions of mathematical thought, such as geometry and topology, mathematical analysis, algebra and number theory, and discrete mathematics. Courses in this area include the following:

MATH 141	QR:Real Anlys in One Variable	3
MATH 151	QR: Groups and Rings	3
MATH 173	QR: Basic Combinatorial Theory	3
MATH 236	QR: Calculus of Variations	3
MATH 240	QR:Fourier Series&Intgrl Trans	3
MATH 241	QR:Anyl in Several Real Vars I *	3
MATH 242	QR:Anyl Several Real Vrbes II	3
MATH 251	QR: Abstract Algebra I *	3
MATH 252	QR: Abstract Algebra II	3
MATH 255	QR:Elementary Number Theory	3
MATH 257	QR:Topics in Group Theory	3
MATH 260	QR: Foundations of Geometry	3
MATH 264	QR: Vector Analysis	3
MATH 273	QR:Combinatorial Graph Theory	3
MATH 331	Theory of Func of Complex Var	3
MATH 353	Point-Set Topology	3

2. Applied Mathematics

Applied mathematics involves the use of mathematical methods to investigate problems originating in the physical, biological, and social sciences, and engineering. Mathematical modeling, coupled with the development of mathematical and computational solution techniques, illuminates mechanisms which govern a problem and allows predictions to be made about an actual physical situation. Current research interests of the faculty include biomedical mathematics, fluid mechanics and hydrodynamic stability, asymptotics, and singular perturbation theory. Courses in this area include the following:

MATH 230	QR:Ordinary Diffrntl Equation *	3
MATH 236	QR: Calculus of Variations	3
MATH 237	QR:Intro to Numerical Analysis *	3
MATH 238	QR:Appld Computational Methods	3
MATH 240	QR:Fourier Series&Intgrl Trans	3
MATH 272	QR: Applied Analysis	3
MATH 273	QR:Combinatorial Graph Theory	3
MATH 274	QR:Numerical Linear Algebra	3

3. Computational Mathematics

Computational mathematics involves both the development of new computational techniques and the innovative modification and application of existing computational strategies to new contexts where they have not been previously employed. Intensive computation is central to the solution of many problems in areas such as applied mathematics, number theory, engineering, and the physical, biological and natural sciences. Computational mathematics is often interdisciplinary in nature, with algorithm development and implementation forming a bridge between underlying mathematical

results and the solution to the physical problem of interest. Courses in this area include the following:

MATH 173	QR: Basic Combinatorial Theory	3
MATH 230	QR:Ordinary Diffrntl Equation	3
MATH 237	QR:Intro to Numerical Analysis *	3
MATH 238	QR:Appld Computational Methods	3
MATH 274	QR:Numerical Linear Algebra	3
STAT 201	QR:Stat Computing&Data Anlysis	3

4. Theory of Computing

The mathematical theory of computing deals with the mathematical underpinnings allowing effective use of the computer as a tool in problem solving. Aspects of the theory of computing include: designing parallel computing strategies (graph theory), analyzing strengths and effectiveness of competing algorithms (analysis of algorithms), examining conditions which ensure that a problem can be solved by computational means (automata theory and computability), and rigorous analysis of run times (complexity theory). Courses in this area include the following:

MATH 173	QR: Basic Combinatorial Theory	3
MATH 273	QR:Combinatorial Graph Theory	3
CS 224	QR:Algorithm Design & Analysis *	3
CS 243	QR: Theory of Computation	3

5. Mathematics of Management

Mathematics of Management involves the quantitative description and study of problems particularly concerned with the making of decisions in an organization. Problems are usually encountered in business, government, service industries, etc., and typically involve the allocation of resources, inventory control, product transportation, traffic control, assignment of personnel, and investment diversification. Courses in this area include the following:

MATH 173	QR: Basic Combinatorial Theory	3
MATH 221	QR:Detrministc Modls Oper Rsch *	3
MATH 222	QR:Stochastic Models:Oper Rsch	3
MATH 230	QR:Ordinary Diffrntl Equation	3
MATH 236	QR: Calculus of Variations	3
MATH 273	QR:Combinatorial Graph Theory	3
STAT 141	QR:Basic Statistical Methods 1	3
or STAT 211	QR: Statistical Methods I	
STAT 151	QR: Applied Probability	3
or MATH 207	QR: Probability Theory	
STAT 224	QR:Stats for Qualty&Productvty	3
STAT 241	QR: Statistical Inference	3
STAT 253	QR:Appl Time Series&Forecastng	3

6. Actuarial Mathematics

Actuaries use quantitative skills to address a variety of risk related problems within financial environments. A unique feature of the actuarial profession is that a considerable amount of the formal training is typically completed after graduation "on-the-job".

The Society of Actuaries is an international organization that regulates education and advancement within the profession. Candidates may earn designation as an Associate of the Society of Actuaries (ASA) by satisfying three general requirements. These are:

1. Preliminary Education Requirements, PE;
2. the Fundamentals of Actuarial Practice Course, FAP; and
3. the Associateship Professionalism Course, APC.

The multiple component FAP is based on an e-learning format, and can be pursued independently. After completing the PE and at least one of the FAP components, candidates are eligible to register for the one-half day APC.

The Preliminary Education Requirements consist of

1. prerequisites
2. subjects to be validated by educational experience (VEE), and
3. four examinations.

While at the university, students can satisfy the prerequisites, the VEE courses, and the first two preliminary examinations. The following courses are recommended as preparation for the specific requirements.

Prerequisites

CALCULUS		
MATH 021	QR: Calculus I	4
MATH 022	QR: Calculus II	4
MATH 121	QR: Calculus III	4
LINEAR ALGEBRA		
MATH 124	QR: Linear Algebra	3
INTRODUCTORY ACCOUNTING		
BSAD 060	Financial Accounting	3
BSAD 061	Managerial Accounting	3

MATHEMATICAL STATISTICS		
STAT 261	QR: Statistical Theory	3

These are topics that will assist candidates in their exam progress and work life but will not be directly tested or validated.

Subjects Validated by Educational Experience

ECONOMICS		
EC 011	Principles of Macroeconomics	3
EC 012	Principles of Microeconomics	3
CORPORATE FINANCE		
BSAD 180	Managerial Finance	3
BSAD 181	Intermediate Financial Mgmt	3
APPLIED STATISTICAL METHODS		
STAT 221	QR: Statistical Methods II	3
STAT 253	QR:Appl Time Series&Forecastng	3

Candidates will demonstrate proficiency in these subjects by submitting transcripts.

Preliminary Examinations

EXAM P - PROBABILITY		
STAT 151	QR: Applied Probability	3
STAT 251	QR: Probability Theory	3
EXAM FM - MATHEMATICS OF FINANCE		
BSAD 180	Managerial Finance	3
BSAD 181	Intermediate Financial Mgmt	3

Other applicable departmental courses include:

STAT 195	Intermediate Special Topics	1-18
STAT 201	QR:Stat Computing&Data Anlysis	3
STAT 225	QR:Applied Regression Analysis	3
STAT 229	QR:Survivl/Logistic Regression	3
STAT 235	QR: Categorical Data Analysis	3
STAT 237	QR: Nonparametric Statis Mthd	3
MATH 173	QR: Basic Combinatorial Theory	3
MATH 221	QR:Detrministc Modls Oper Rsch	3
MATH 222	QR:Stochastic Models:Oper Rsch	3

7. Probability and Statistical Theory

Probabilistic reasoning is often a critical component of practical mathematical analysis or risk analysis and can usefully extend classical deterministic analysis to provide stochastic models. It also provides a basis for statistical theory, which is concerned with how inferences can be drawn from real data in any of the social or physical sciences. Courses in this area include the following:

MATH 222	QR:Stochastic Models:Oper Rsch	3
MATH 241	QR:Anyl in Several Real Vars I	3
MATH 242	QR:Anyl Several Real Vrbes II	3
MATH 207	QR: Probability Theory *	3
or STAT 151	QR: Applied Probability	
STAT 241	QR: Statistical Inference *	3
STAT 252	Appl Discr Stochas Proc Models (a)	1
STAT 252	Appl Discr Stochas Proc Models (b)	1
STAT 261	QR: Statistical Theory	3

RECOMMENDATIONS FOR ALLIED FIELD COURSES

Students should discuss Allied Field courses with their advisor and choose ones that complement their mathematical interests. Students with certain mathematical interests are advised to emphasize an appropriate Allied Field as indicated below and take at least six credits in courses numbered 100 or above in that field.

Applied Mathematics

Allied Field (1), (2), (3), (4), (6), or (9).

Computational Mathematics

Allied Field (4) or (5).

Mathematics of Management

Allied Field (7). Students interested in Mathematics of Management are advised to include economics (EC 011 and EC 012) in their choice of Humanities and Social Sciences courses, and to include business administration (BSAD 060 and BSAD 061) in their choice of Allied Field courses. Those wishing to minor in business administration should contact the School of Business Administration and also take BSAD 173 and two other courses chosen from business administration Allied Field courses.

DOUBLE MAJOR IN MATHEMATICS AND STATISTICS

Students may earn a double major in mathematics and statistics by meeting the requirements of the statistics major and earning an additional fifteen credits in mathematics, to include:

MATH 052	QR:Fundamentals of Mathematics	3
Choose two of the following:		6
MATH 230	QR:Ordinary Diffrntl Equation	
MATH 237	QR:Intro to Numerical Analysis	
MATH 241	QR:Anyl in Several Real Vars I	
MATH 251	QR: Abstract Algebra I	

Note: Student pursuing the double major in mathematics and statistics must earn a total of 120 credits. The above outlined courses must be additional to the courses defined for the stat major (core, major, allied field and HSS).