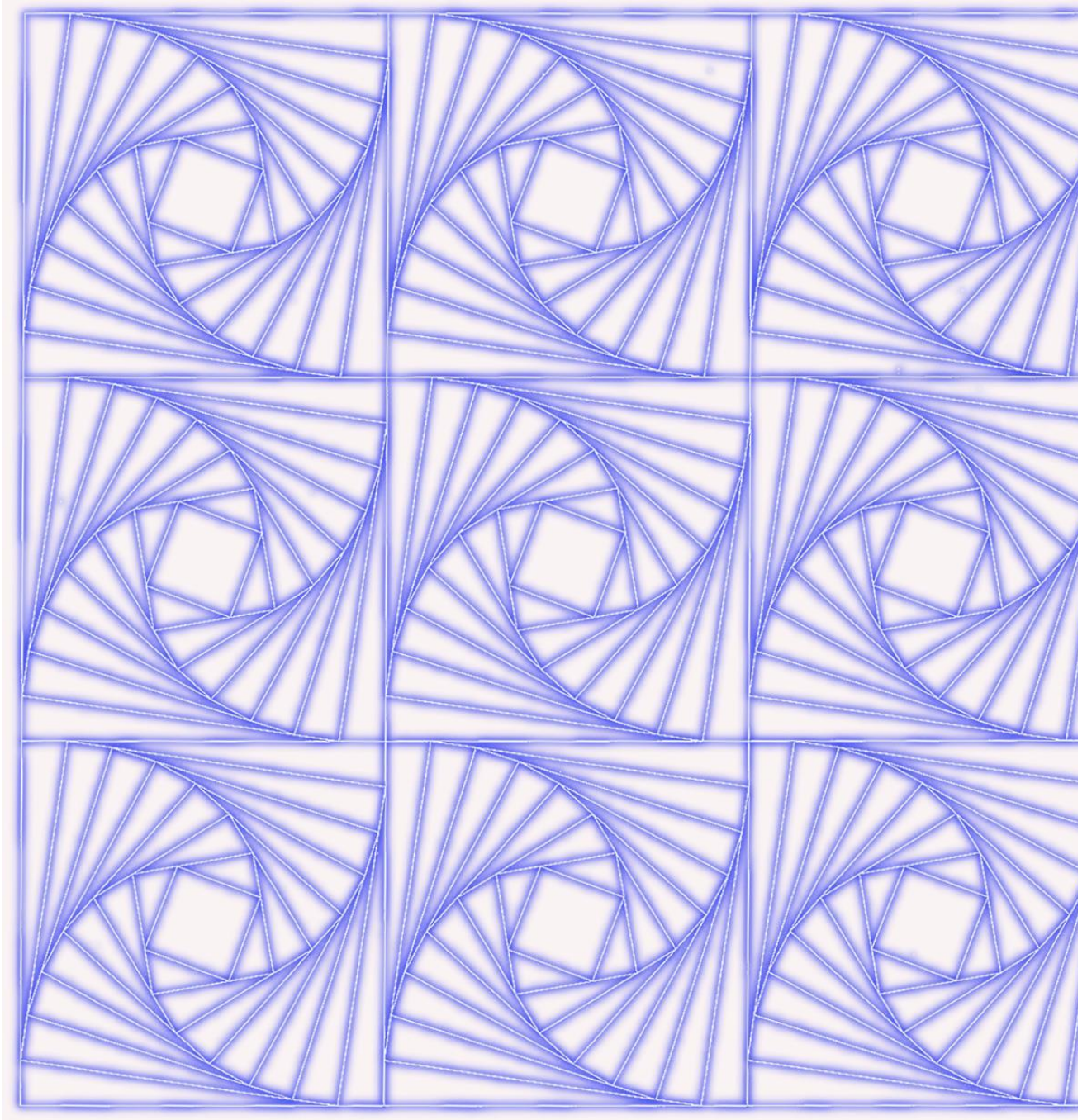# MATHEMATICS
Undergraduate Program

2020-2021
THE DEPARTMENT OF MATHEMATICS
UNIVERSITY OF SOUTH CAROLINA—COLUMBIA

August 25, 2020

FURTHER ASSISTANCE IS AVAILABLE FROM:

Dr. Xinfeng Liu
Undergraduate Director
   LeConte 317Q
   Phone: 777-5313
   E-mail: ugraddir@math.sc.edu

DeeAnn Moss
Undergraduate Program Administrator
   LeConte 413
   Phone: 777-5313
   E-Mail: mossdc@math.sc.edu

Dr. Linyuan (Lincoln) Lu
Chair
   LeConte 409
   Phone: 777-4225
   E-mail: chair@math.sc.edu

Dr. Adela Vraciu
Assistant Chair
   LeConte 300C
   Phone: 777-4757
   E-mail: achair@math.sc.edu

Dr. Loren W. Knapp
Assistant Dean
   Flinn Hall
   Phone: 777-2505
   E-mail: lwknapp@cas.sc.edu

Dr. Matthew Boylan
Graduate Director
   LeConte 400C
   Phone: 777-7542
   E-mail: graddir@math.sc.edu

MT and MAT Advisor Department of Education

Dr. Jan Yow
   Wardlaw 224
   Phone: 777-2472
   E-mail: yow@mailbox.sc.edu

Note: *Students interested in the Master of Arts in Teaching (MAT) degree may also obtain information from the Department of Mathematics Graduate Director.*

IMPORTANT USC WEBSITES

my.sc.edu
Undergraduate Academic Bulletin
Blackboard
Registrar's Office
Student Success Center
Supplemental Instruction

Career Center
Department of Mathematics
College of Arts and Sciences
University of South Carolina
University Advising Center

This booklet is found at
https://sc.edu/study/colleges_schools/artsandsciences/mathematics/my_mathematics/undergrads/

DegreeWorks

DegreeWorks is a web-based tool for you to monitor your academic progress toward degree completion by reviewing a degree audit. It allows you and your advisor to plan future coursework. DegreeWorks reorganizes your transcript chronologically and categorically, easily identifying courses you have completed and what courses you still need in order to fulfill your degree requirements. While efforts have been made to ensure accuracy; final responsibility for meeting requirements resides with the student.

A GUIDE FOR UNDERGRADUATE MAJORS
IN
MATHEMATICS

WHAT IS MATHEMATICS?

Did you ever notice those little whirlpools, or vortices, that are swept downstream from the piers of a bridge, or that spin off the end of your oar when you are rowing a boat? That same thing happens in the slipstream of a car or an airplane, or in the wind blowing past a tall building. In some instances, it may be a small effect, but at higher velocities, they may affect the drag on a car or an airfoil and in extreme cases, the resonance produced may be large enough to bring down bridges or the cooling towers of a power station. In studying the case of a wind tunnel or any other situations, a scale model has to be built and modified every time changes are desired.

Here is where the mathematics comes in; we build a mathematical model. The only real construction that goes on here is in our minds. By formulating the mathematical equations that govern the process, we can attempt to solve them mathematically to obtain a description of what will happen in the real world. This is not always an easy process. Often the models have to be so complicated to take into account all the factors involved that solving them explicitly is impossible. However, sophisticated mathematical techniques can be used to generate approximate solutions on high-speed computers. The mathematics allows us to build the model, to go as far as we can with theoretical means to solve it, to organize it in a suitable form for computer processing, and to analyze the results. Frequently, the results obtained provide new insights into the mechanisms involved, thereby enabling the mathematical model to be improved.

The process is called computer simulation. It is used extensively in the design of automobiles and airplanes, in energy resource discovery and recovery, and to understand complex industrial processes such as chemical reactions or the reactions that occur inside a nuclear reactor. This is mathematics at work. Remember that the computer only does what it is told to do (very quickly, of course), and so highly trained mathematical scientists, teamed with specialists from other areas, are essential to the success of such ventures. Industry is increasingly turning to mathematical modeling and computer simulation as the primary tools in its research and development operations, particularly since the advent of the supercomputer.

Does all of mathematics require the use of a computer? Not at all, but the process of discovery in any area of mathematics is similar to that in modeling and simulation. The problem is formulated in mathematical terms, modeled, analyzed, perhaps only partially resolved, modified, analyzed again, and so on, until a solution is obtained. And all of science is so inherently mathematical that expertise in mathematics is essential nowadays in virtually every branch of science and engineering, and even in business administration and the social sciences. Mathematics is indeed the language of science, the universal means of expression, and the source of communication between diverse disciplines.

CAREER OPPORTUNITIES IN MATHEMATICS

In today's world of rapidly expanding technology, there are many career opportunities for the well-qualified mathematician. Business, government, and industry have strong needs for mathematicians in areas such as operations research, optimization, numerical analysis, computer programming, systems analysis, communications, statistics, and information and actuarial science. Whether it be in operations research, systems analysis, computer software and hardware development, modeling and simulation, numerical analysis, development and test of algorithms, cryptology, or teaching, some familiarity with computers and the mathematics of computation is usually essential. The mathematics degree, at the baccalaureate, masters, or doctoral level, provides the grounding in analytical thinking and the scientific skills necessary to function in today's interdisciplinary environment. The Bachelor of Science degree is a sound preparation for graduate study in mathematics or any of the mathematical sciences, but also for advanced degrees in business administration and some of the quantitative social sciences. A bachelor's degree in mathematics can also provide entry to careers in fields such as management, engineering, banking, insurance, government service, the military, and geology.

An excellent source for information about careers in the mathematical sciences is the [Mathematical Association of America (MAA)](). The pamphlet "Careers in the Mathematical Sciences" provides an indication of the variety of [careers]() available to persons with interest and preparation in the mathematical sciences. Copies may be obtained from the Department of Mathematics Undergraduate Office in LeConte College 413. The US Department of Labor, Bureau of Labor Statistics, maintains an [Occupation Outlook Handbook](). This is an excellent source of general information about almost any career. The following websites are also sources of career information in mathematics, applied mathematics, and actuarial science: [The American Mathematical Society (AMS)](), the [Society for Industrial and Applied Mathematics (SIAM)]() , [beanactuary](), and [we use math]() .

The following is a partial list of employers who were recruiting math majors on campus during recent years:

[Accenture]()	[Mass Mutual]()	[Texas Instruments]()
[AT&T]()	[Microsoft Corporation]()	[United States Air Force]()
[Blue Cross/Blue Shield of South Carolina]()	[National Security Agency]()	[United States Bureau of Labor Statistics]()
[Central Intelligence Agency]()	[Naval Air Systems Command]()	[United States Bureau of the Census]()
[Colonial Life]()	[Naval Surface Weapons Center]()	[United States Coast Guard]()
[Computer Services Corporation (CSC)]()	[National Cash Register (NCR)]()	[United States Department of Energy]()
[Computer Task Group]()	[South Carolina Department of Education]()	[United States General Accounting Office]()
[Duke Power Company]()	[Southern Teachers Agency]()	[United States Office of Comptroller of the Currency]()
[Gildan Branded Apparel]()	[State Farm Insurance]()	[Westinghouse]()
[Hawkes Learning Systems]()		[Xerox]()
[Kennedy Space Center]()		

Job prospects depend on your educational background and personal interest. Mathematics majors are encouraged to take several courses in a field that uses or is closely related to mathematics. Popular choices include education, statistics, biology or other physical science, business, finance, and computer science. A double major in mathematics and computer science, or mathematics and statistics, is particularly attractive to employers. The actuarial emphasis combines a major in mathematics with a strong background in statistics and business (accounting, economics, and finance). This program is particularly suited for students interested in becoming an actuary or other finance-related career.

DEGREE PROGRAMS

The Department of Mathematics offers the Bachelor of Science degree in Mathematics. The major is completed with 120 semester hours of overall coursework. The BS in Mathematics requires 27 semester hours (9 courses) of mathematics beyond calculus. Four of these courses are required of all students, the other five can be chosen to best fit each student's interests and desires. Two auxiliary courses in Computer Science and Statistics are also required. Four common pathways to complete the mathematics electives are:

- **General Mathematics –** Requires 27 semester hours of mathematics courses beyond calculus (comprising the required core of 12 semester hours and 15 semester hours of mathematics electives). Students interested in pursuing a graduate degree in mathematics should complete their mathematics electives to include at least one of the two-course sequences in algebra or analysis and often complete the B.S. in Mathematics in Distinction (described below).

- **Mathematics Education –** Leads to a bachelor's degree in mathematics, with a 12-semester hour education cognate. Certification is obtained upon completion of the Master of Teaching degree program in Secondary Education. In addition to the four core courses, the pathway includes courses in number theory and geometry.

- **Applied Mathematics –** Offers specialization in applied or computational mathematics. Students are encouraged to select a diverse set of mathematics electives in such disciplines as differential equations and modeling, discrete mathematics, financial mathematics and probability, optimization and computation, and analysis. Applied mathematics majors are encouraged to select a cognate, minor, or second major that complements their mathematical interests; common choices include computer science, statistics, one of the physical sciences, and engineering.

- **Actuarial Mathematics –** Offers a program of study designed to prepare students for the actuarial profession in the insurance and financial securities industries. In addition to the required core mathematics courses, this pathway includes mathematics courses in probability, differential equations, discrete mathematics, and optimization. In addition to several Statistics courses, students should complete courses in Accounting, Economics, and Finance that satisfy the requirements for a minor in Risk Management and Insurance. Some actuarial students choose to pursue double majors in Mathematics and Statistics (and the minor in Risk Management and Insurance).

In addition to the major requirements, each student is required to complete a minor (18 hours of courses related to a common topic) or a cognate (12 hours of integrated courses from a single department) in a discipline related to, but distinct from the major. Note that the Actuarial and Education pathways include a cognate and/or minor.

The **B.S. in Mathematics with Distinction** is awarded to students who complete an additional 12 semester hours of approved upper-division mathematics courses, an undergraduate research experience, and an undergraduate thesis.

ADVISING

Initial advising for first year students and transfer students with fewer than 45 credit hours takes place at orientation and is handled by your assigned First Year Advisor (FYA) with input as needed from a representative of the Department of Mathematics, usually the Undergraduate Director. You will have the opportunity to meet with your FYA several times in the first year to discuss course selection and any other issues that may arise (academic or personal difficulties, plans for the major or change of major, withdrawal procedures, career goals and opportunities, etc.). In 2019-2020 the FYA for Mathematics is Jenny Leist, 777-2419, Jones PSC 108, sweitzej@mailbox.sc.edu .

In your second year you may have a transitional advisor until you have completed MATH 241 and 300; after that you will be assigned a Mathematics Department faculty member as a more permanent advisor for the upper division part of the program. While the primary role of the departmental advisor is to help select courses for the following semester and plan your longer term academic program, your advisor can also help you find further resources on campus for help with problems that may arise; for variations of requirements under exceptional circumstances; for scholarship, study abroad, research, internship, and service learning opportunities; and for graduate school options. Every student must be advised in order to be cleared to register for the following semester.

Note that the advisor provides only guidance; the student has final responsibility for staying fully informed of University deadlines and academic policies.

Each semester there is an advising period in which you must set up an appointment with your advisor. During a transitional period some advisors may use email and others may use web based appointment software. If you find yourself two or three weeks before your registration window and not made contact with your advisor, please consult with the Undergraduate Program Administrator. *To increase your likelihood of getting the courses you want and need, be certain to be advised during the regular advisement period.*

A *Senior Records Check* needs to be completed one year before you plan to graduate. When you have earned approximately 95 credit hours, ask your advisor to complete a *Major Program Card*. This involves listing all major and cognate/minor/second major requirements, completed, in progress, and anticipated, while you still have time to complete them without delaying your graduation.

AWARDS AND SCHOLARSHIPS

The Department of Mathematics and College of Arts and Sciences recognize continuing and graduating students at the end of each academic year. The current list of awards and scholarships, with brief descriptions, is shown below. The Undergraduate Program Committee solicits applications from interested students each spring; the awards are announced and presented at Undergraduate Awards Day.

Outstanding Undergraduate Student in Mathematics Education
... presented yearly to an outstanding undergraduate student in mathematics education who has exhibited excellence in the mathematics program.

Outstanding Undergraduate Student in Mathematics
... presented yearly to an outstanding undergraduate student who has exhibited excellence in the mathematics program.

College of Arts and Sciences Rising Senior Award
... awarded annually by the College of Arts and Sciences to a rising senior mathematics major who has demonstrated excellence in mathematics and has a cumulative GPA of at least 3.50.

James Bruce Coleman Mathematics Scholarship
... awarded annually by the Department of Mathematics to an outstanding mathematics major from South Carolina. The scholarship was established in 1992 by Joseph Harold Burckhalter (Class of 1934), in memory of the late James Bruce Coleman, who was a professor of mathematics and head of the department from 1915—1942.

Thomas Markham Mathematics Scholarship
... awarded annually to an outstanding mathematics major who also has significant extracurricular mathematical activities. The scholarship was established in 1999 in honor of Professor Emeritus Thomas Markham, who was a professor of mathematics from 1968—1999 and undergraduate director 1996—1999.

Victor W. Laurie Undergraduate Research Scholarship
... provides monetary support for an undergraduate student interested in being involved with mathematical research. This is a competitive award based on proposals submitted by all interested students.

Dr. Edwin R. and Mrs. Elizabeth F. Jones Endowed Scholarship
... awarded cooperatively by the Departments of Chemistry, Mathematics, and Physics to South Carolina resident majoring in one or more of chemistry, mathematics, and physics. The Jones family created this scholarship in 2013 to recognize students in chemistry, mathematics, and physics. The application for this scholarship can be obtained from the College of Arts and Sciences.

Lovelace Family Endowed Scholarship
... awarded bi-annually by the Department of Mathematics to an outstanding undergraduate mathematics major who had demonstrated excellence in mathematics. The Lovelace family created this scholarship in 2013 to recognize students in mathematics and physics. Awards alternate between mathematics and physics.

Pi Mu Epsilon Award
... presented annually to an outstanding member of Pi Mu Epsilon based on performance in mathematics courses and service to the department.

Polston Family Mathematics Scholarship
... is awarded to undergraduate mathematics students who are excelling in the mathematics program. The Polston family established the scholarship in 2008.

Cary K. Smith, Jr., Mathematics Scholarship
... awarded annually by the Department of Mathematics to an outstanding undergraduate mathematics major who has demonstrated excellence in mathematics and leadership. The scholarship was established in 1998 in memory of Cary Kincaid Smith, Jr., an Honors graduate of USC who died while performing his duties as a pilot in the U.S. Marine Corps.

Wyman L. Williams Scholarship
... awarded to an undergraduate mathematics major at the University of South Carolina. Can be renewed for not more than 3 additional years of undergraduate study. Wyman L. Williams came to the University in 1919 as a freshman, joined the Mathematics Department faculty in 1924 and retired in 1970 as Distinguished Professor Emeritus. The Wyman L. Williams Mathematics Scholarship Fund was established in 1975.

Jeong S. Yang Award for Excellence in Undergraduate Mathematics
... awarded yearly to outstanding undergraduate mathematics majors at the University of South Carolina selected from students who have earned at least 100 credit hours and have completed at least 3 of the 4 core mathematics courses required for the major with a GPA of at least 3.70 in all upper-division mathematics courses. The award was established by the Department of Mathematics in memory of the late Professor Jeong S. Yang, undergraduate director 1984—1995.

MATHEMATICS FACULTY

PROFESSORS

Peter G. Binev, Ph.D.,
University of Sofia, 1985

Matthew Boylan, Ph.D.,
Graduate Director
University of Wisconsin at Madison, 2002

Joshua N. Cooper, Ph.D.,
University of California, San Diego, 2003

Eva Czabarka, Ph.D.,
University of South Carolina, 1998

Wolfgang Dahmen, Ph.D.,
RWTH Aachen, Germany, 1976

Stephen J. Dilworth, Ph.D.,
Cambridge University, 1985

Michael A. Filaseta, Ph.D.,
University of Illinois, 1984

Maria Girardi, Ph.D.,
University of Illinois, 1990

Ralph E. Howard, Ph.D.,
California Institute of Technology, 1982

Lili Ju, Ph.D.,
Iowa State University, 2002

Andrew Kustin, Ph.D.,
University of Illinois, 1979

Xinfeng Liu, Ph.D.,
Undergraduate Director,
SUNY at Stony Brook, 2006

Linyuan (Lincoln) Lu, *Chair*
Ph.D., University of California,
San Diego, 2002

George F. McNulty, Ph.D.,
University of California, Berkeley, 1972

Matthew Miller, Ph.D.,
University of Illinois, 1979,

Peter J. Nyikos, Ph.D.,
Carnegie Mellon University, 1971

Pencho Petrushev, Ph.D.,
University of Sofia, 1977

Anton R. Schep, Ph.D.,
University of Leiden, 1977

László A. Székely, Ph.D.,
Eötvös University, 1983

Vladimir Temlyakov, Ph.D.,
Carolina Distinguished Professor
Steklov Institute, 1981

Adela Vraciu, Ph.D.,
Assistant Chair,
University of Michigan, 2000

Hong Wang, Ph.D.,
University of Wyoming, 1992

Qi Wang, Ph.D.,
Ohio State University, 1991

Xiaofeng Yang, Ph.D.,
Purdue University, 2007

ASSOCIATE PROFESSORS

George Androulakis, Ph.D.,
University of Texas, 1996

Matthew R. Ballard, Ph.D.,
University of Washington, 2008

Daniel B. Dix, Ph.D.,
University of Chicago, 1988

Alexander Duncan, Ph.D.,
University of British Columbia, 2011

Jesse Kass, Ph.D.,
Harvard University, 2009

Douglas B. Meade, Ph.D.,
Carnegie Mellon University, 1989

Yi Sun, Ph.D.,
Princeton University, 2006

Frank Thorne, Ph.D.,
University of Wisconsin at Madison, 2008

Ognian T. Trifonov, Ph.D.,
University of Sofia, 1990

Paula A. Vasquez, Ph.D.,
University of Delaware, 2007

Zhu Wang, Ph.D.,
Virginia Polytechnic Institute, 2012

Xian Wu, Ph.D.,
Harvard University, 1986

Sean Yee, Ph.D.,
Kent State University, 2012

ASSISTANT PROFESSORS

Wuchen Li, Ph.D.
Georgia Institute of Technology, 2017

Changhui Tan, Ph.D.
University of Maryland, 2014

CLINICAL ASSOCIATE PROFESSOR

Debra Geddings, Ph.D.,
University of South Carolina, 2003

SENIOR INSTRUCTORS

Ronda Sanders, M.S.,
University of South Carolina, 2004

INSTRUCTORS

Jason Broadway, M.S.,
Middle Tennessee State Univ, 2009

Scott Dunn, Ph.D.,
University of South Carolina, 2014

Erin Hanna, M.S.,
University of South Carolina, 2018

Daniel Savu, Ph.D.,
University of South Carolina, 2009

Shaoyun Yi, Ph.D.,
University of Oklahoma, 2019

DISTINGUISHED PROFESSORS
EMERITI

Colin Bennett, Ph.D.,
University of Newcastle upon Tyne, 1971

Ronald A. DeVore, Ph.D.,
*Robert L. Sumwalt Distinguished Professor
Emeritus*
Ohio State University, 1967

Jerrold R. Griggs, Ph.D.,
Massachusetts Institute of Technology, 1977

Thomas L. Markham, Ph.D.,
Auburn University, 1967

James W. Roberts, Ph.D.,
Rutgers University, 1970

H. Edward Scheiblich, Ph.D.,
University of Texas, 1966

Robert M. Stephenson Jr., Ph.D.,
Tulane University, 1967

Robert C. Sharpley, Ph.D.,
University of Texas, 1972

Manfred Stoll, Ph.D.,
Pennsylvania State University, 1971

David P. Sumner, Ph.D.,
University of Massachusetts, 1971

FACULTY EMERITI

Peter W. Harley III, Ph.D.,
University of Georgia, 1966

Karl H. Matthies,
Dr. Rerum Naturalium,
University of Freiburg, 1956

Charles A. Nicol Jr., Ph.D.,
University of Texas, 1954

Mary Ellen O'Leary, M.A.,
University of Michigan, 1967

Konstantin Oskolkov, Ph.D.,
Steklov Institute, 1978

THE B.S. PROGRAM IN MATHEMATICS

1. Carolina Core Plus College of Arts and Sciences

COLLEGE CORE PLUS COLLEGE OF ARTS AND SCIENCES

I. Effective, Engaged, and Persuasive Communication (CMW)   6 hrs

ENGL 101	Composition	(CMW)
ENGL 102	Composition and Literature	(CMW & INF, when taken at USC)

ENGL 101 and 102 **must each be passed with a grade of C or higher**, and must be completed within the first sixty hours of the degree in order to be counted toward the total needed for graduation.

II. Analytical Reasoning and Problem Solving (ARP)   12 hrs

Students pursuing a Bachelor of Science degree in Mathematics must complete 12 hours as described below.

MATH 141 and 142	(ARP – CC)
CSCE 145 or 206	(ARP – AS)
STAT 509, 512, or 515	(ARP – AS)

III. Scientific Literacy (SCI)   8 hrs

Two Carolina Core-approved[1] laboratory courses selected from Anthropology, Astronomy, Biological Science, Chemistry, Environmental Science, Geography 201, 202 (for Bachelor of Arts degrees only) **Geology, Marine Science, and Physics.** Each science course must have a co-requisite laboratory. The two courses need not be taken in the same field. Lab credit cannot be applied unless its co-requisite lecture is also applied. Some of the more commonly selected courses appear in the following list – it is not exhaustive.

ANTH	161
ASTR	101
BIOL	101/L, 102/L, 110 or 120/L, 200/L or 270/L
CHEM	102, 105, 107, 111/L (or 141), 112/L (or 142)
	Note: Credit cannot be given for both CHEM 111/L and 141 or for CHEM 112/L and 142.
ENVR	101/L or 200/L
GEOG	201 or 202
GEOL	101, 102, 103, or 215/L
MSCI	101, 102, 210/L, or 215/L
PHYS	151/L, 153/L, 155/L, 201/L, 202/L, 211/L, or 212/L
	Note: Credit cannot not be given for both PHYS 151 and 153 or for both PHYS 151 and 155.

IV. Global Citizenship and Multicultural Understanding: Language (GFL)   0-9 hrs

Proficiency in one foreign language is equivalent to the minimal passing grade on the exit examination in the 122 course. Students can demonstrate this proficiency by successfully completing Phase II of the Proficiency Test or by successfully completing the 122 course, including the exit exam administered as part of that course.

V. Global Citizenship and Multicultural Understanding: Historical Thinking (GHS)   6 hrs

Both history courses must be at the 100 level

HIST 10x	Non-US History	3 hrs	(GHS – AS)
HIST 11x	US History	3 hrs	(GHS – CC)

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[1] The full list of Carolina Core- approved courses can be found at
https://sc.edu/about/offices_and_divisions/provost/academicpriorities/undergradstudies/carolinacore/courses/index.php

VIa. Global Citizenship and Multicultural Understanding (GSS)   3 hrs

One Carolina Core-approved social science course[1].

VIb. College of Arts and Sciences Global Citizenship and Multicultural Understanding 3 hrs

One additional course in the social sciences. This does not have to be a Carolina Core-approved course, but does need to be approved by the College of Arts and Sciences. Some of the more common choices are listed below:

ANTH   {excluding 161}
COLA   {pending content}
CRJU   {excluding 202, 301, 399, 494}
ECON
GEOG   {excluding 201, 202}
LASP   {301, 311, 312, 315, 322, 325, 331, 351, 398 pending content, 425, 451, 454, 455 only}
LING   {300, 340, 405 pending content, 442, 505 pending content, 540, 541, 542, 543, 545, 567, 570, 600 only}

POLI
PSYC   {excluding 226, 227, 228}
SOCY   {excluding 220}
SOST   {298, 299, 301, 302 pending content, 305, 405 pending content}
SSCI   {001T, 003T}
WGST   {112, 210, 300, 301, 304, 305, 307, 308, 310, 351, 352, 358, 381, 430 pending content, 454, 525, 554, 555}

VIIa. Aesthetics and Interpretive Understanding (AIU)   3 hrs

Fine Arts or Literature:
Excluding 399, internships, Senior Seminar and Senior thesis courses

a) **Fine Arts**

A Carolina Core-approved[1] course dealing with the study and/or practice of the visual and performing arts. Students may take a course in art studio, art design, art history and appreciation, film, media arts, music history and appreciation, music theory and performance, theatre history and appreciation, acting, stagecraft, theatre design, and dance to fulfill this requirement.

Courses in speech (SPCH) apply to the humanities requirement, but **DO NOT** satisfy the fine arts requirement. Theatre production laboratories (THEA 119, 120, 121, 122, 123, 219, 220, 221), one-hour credits for participation in music organizations (band, chorus, orchestra), DANC 177, 577, and MART 302 do NOT apply to the fine arts requirement or to the humanities requirement.

b) **Literature**

A Carolina Core-approved[1] literature course numbered 200 or higher, or a comparative literature course and literature course taught in a foreign language.

VIIb. College of Arts and Sciences Fine Arts and Humanities Requirement   3 hrs

One additional course in the humanities. This does not have to be a Carolina Core-approved course, but does need to be approved by the College of Arts and Sciences. Some of the more common choices are listed below:

AFAM
ARTS
ARTE   {excluding 465, 471, 565, 595}
ARTH
CLAS
CPLT
DANC {excluding DANC177, 577}
ENGL
EURO
FILM
HIST
LANG   {ARAB, CHIN, FREN, GERM, GREK, ITAL, JAPA, LATN, PORT, RUSS, SPAN, (excluding 1xx, 315)}
LASP   {LASP 201, 301, 341, 342, 361, 371, 398 pending content, 441, 442, 447, 471, 481, 501, 541 only}

LING   {LING 301, 405 pending content, 421, 431, 440, 441, 442, 502, 503, 504, 505 pending content, 512, 514, 530, 540, 565, 600, 610, 620, 627, 650 only}
MART   {excluding MART 302}
MUSC   {excluding one-hour credits for participation in music organizations, 399}
PHIL   {excluding 110, 111, 511}
RELG
SOST   {298, 299, 301, 302 pending content, 305, 405 pending content}
SPCH
THEA   {excluding THSP 119, 120, 121, 122, 123, 219, 220, 221}
WGST   {111, 307, 308, 320, 321, 376, 379, 437, 464, 485, 535 pending content, only}

VIII. Overlay

3-9 hrs

Two of the three overlay courses[1] can fulfill General Education requirements. At least one overlay course must stand alone. Overlay courses cannot be used to fulfill a major/cognate/minor requirement.

    a.   Effective, Engaged, and Persuasive communication: Spoken Component **(CMS)**
    b.   Information Literacy **(INF)**
    c.   Values, Ethics, and Social Responsibility **(VSR)**

TOTAL HOURS in Carolina Core Plus for College of Arts and Sciences: **50-65 hrs**

2. Pre-Major requirements

The following pre-major courses may fulfill some requirements of the Carolina Core Plus for CAS.
    a)   MATH 141, MATH 142, MATH 241, and MATH 300 (each with a grade of C or better)
    b)   at least one of CSCE 145 or CSCE 206
    c)   at least one of STAT 509, STAT 512, or STAT 515(Note: STAT 512 has a prerequisite of MATH 511)

3. Major Requirements

RETENTION

1.   A grade of ***C*** or better is required in each major course and in each of MATH 141, 142, 241, and 300.
2.   A student may enroll in each major course and in each of MATH 141, 142, 241, and 300 a maximum of two times. **(Enrolled in a course is interpreted to mean that a grade, including W, has been recorded).**
3.   Students may repeat a maximum of three MATH courses (receiving a grade of ***W*** is not considered a repeat).

Students who violate the retention policy can file a petition in the Dean's Office requesting an exception to this policy. Otherwise, the student will have to find a new major.

TRANSFER REQUIREMENTS
In addition to the minimum University and College of Arts and Sciences requirements, a student seeking to transfer to the mathematics major from another program within the University, or from another accredited college or university, is required to have earned a grade of "B" or higher in at least one of the following courses, or their USC equivalent: MATH 141 (Calculus I), MATH 142 (Calculus II), MATH 241 (Vector Calculus), or MATH 300 (Transition to Advanced Mathematics). An AP or IB exam score that provides credit for MATH 142 also satisfies this requirement.

B.S. IN MATHEMATICS (24 hours)

- MATH 544 (MATH 544L is an optional 1-credit hour lab)
- At least one of
    - MATH 511 – Probability (=STAT 511)
    - MATH 520 – Ordinary Differential Equations
    - MATH 534 - Elements of General Topology
    - MATH 550 - Vector Analysis
    - MATH 552 - Applied Complex Variables
- MATH 546 - Algebraic Structures I
- MATH 554 - Analysis I
- At least 12 hours of MATH electives numbered above 500.
  The choice of the four MATH elective courses (MATH 500-599 or 700 and higher with permission) should be made to support the student's educational goals and career objectives.

B.S. WITH DISTINCTION IN MATHEMATICS (39 hours)

Available to students majoring in mathematics who wish to participate in significant research with a faculty mentor.

Prerequisite
A minimum GPA of 3.60 in upper division (500 and above) major courses and 3.30 overall when the student applies to enter the B.S. with Distinction in Mathematics track.

Requirements
The student should apply to enter the B.S. with Distinction in Mathematics track and choose the members of the thesis committee as early as possible, but in all cases at least one year before completion of the degree. An **application** with a plan of study listing courses to be taken and a research proposal must be submitted to the Undergraduate Director for approval. The committee will consist of a thesis advisor, who must be a tenure-track faculty member in Mathematics, and one or two other tenure-track or research faculty members in Mathematics or any other department, as approved by the Undergraduate Program Committee. The senior thesis consists of either significant original work or a synthesis of known material beyond the scope of ordinary undergraduate coursework. The student may use their senior thesis to simultaneously fulfill other requirements as well (e.g., Magellan Scholarship, Honors College Thesis, etc.), at the discretion of the thesis advisor.

By the end of the semester in which the student is admitted into the B.S. with Distinction in Mathematics track, a brief research plan must be agreed upon by the thesis committee and the student, and filed in the Department of Mathematics and College of Arts and Sciences. Besides submitting and defending the thesis, the student must complete three credit hours of MATH 499 (Undergraduate Research) under the supervision of the thesis advisor, and at least 12 hours of upper-level (500-599, or 700-799 with approval by advisor, Graduate Director, and instructor) MATH credit approved by the Undergraduate Director beyond the 24 credit hours of 500-level MATH courses required for the B.S. in Mathematics.

By the end of the student's last semester, the student must present and defend the senior thesis before the thesis committee. The defense must be announced at least one week in advance and be open to the general public. A certificate attesting to a successful defense, signed by the committee, must be placed on file with both the Department of Mathematics and the College of Arts and Sciences. In addition, prior to graduation the student must have either (a) presented the research at a meeting of a professional society, at Discovery Day at USC, or at a comparable venue; or (b) submitted the work for publication in an undergraduate or professional journal.

Students who successfully fulfill all of these requirements with a GPA of at least 3.60 in upper division (500-599, or 700-799 with approval) major courses and 3.30 overall, will be awarded their degree with "Distinction in Mathematics" upon graduation.

GENERAL GUIDELINES FOR SELECTING MATH ELECTIVES

- Students planning **to go to graduate school in mathematics** should complete at least one of the two-semester sequences in algebra (MATH 546 and MATH 547) or analysis (MATH 554 and MATH 555). Completing both two-semester sequences provides the strongest foundation for graduate study in mathematics. Students completing this combination of courses are well on their way towards completing the B.S. with Distinction in Mathematics.

- Students planning **to become mathematics teachers at the secondary (grades 9-12) level** should choose MATH 574, MATH 580, and at least one of MATH 531 or MATH 532. In addition, as a cognate, these students should take

  EDFI 300 - Schools In Communities   EDSE 302 - Teachers and Teaching
  EDPY 401 - Human Growth and Development   EDSE 500 - Equity and Community Engagement

  With two additional Education courses, students complete a minor in Education. This selection of MATH electives and of the education cognate positions students to complete, after completing a B.S. in Mathematics, a one-year graduate Master of Teaching degree from the College of Education and apply for grades 9-12 mathematics licensure in South Carolina

- Students planning **to pursue a career in actuarial science** should declare a minor in Risk Management and Insurance and complete their MATH electives with the following courses:

  MATH 511 - Probability
  MATH 520 - Ordinary Differential Equations   either MATH 524 - Nonlinear Optimization
  MATH 574 - Discrete Mathematics, and   or MATH 570 - Discrete Optimization

  The Risk Management and Insurance Minor is completed by taking ACCT 225, ECON 221 and 222, and FINA 363, 469, 471, and 475. (Note that FINA 469 is a prerequisite for FINA 475.)

To develop a strong basis for success in the initial actuarial examinations (Exams P, FM, MFE), and to qualify for the Society of Actuaries' Validation through Educational Experience (VEE) in Applied Statistics, Economics, and Corporate Finance, students should complete the following collection of 27-33 semester hours in the Department of Statistics and the Darla Moore School of Business. For detailed information about the VEE program

Mathematical Statistics and Statistical Models (9 hours)
>   STAT 512 - Mathematical Statistics
>   STAT 513 - Theory of Statistical Inference
>   ECON 436 - Introduction to Econometrics

Economics and Corporate Finance (12 hours)
>   ACCT 225 - Introduction to Financial Accounting
>   ECON 221 - Principles of Microeconomics
>   ECON 222 - Principles of Macroeconomics
>   FINA 363 - Introduction to Finance

Risk Management and Insurance (0-3 hours)
>   FINA 341 - Management of Risk and Insurance

Finance and Stochastic Processes (3-6 hours) from
>   FINA 469 - Investment Analysis and Portfolio Management
>   FINA 471 - Derivative Securities
>   FINA 475 - Fixed Income Securities
>   STAT 521 - Applied Stochastic Processes

Computing (3 hours) from
>   CSCE 146 - Algorithmic Design II
>   MGSC 390 - Business Information Systems
>   STAT 540 - Computing in Statistics

- Students planning **to undertake further study in applied mathematics or who intend to pursue non-academic mathematical careers**, should consider MATH 544L, MATH 520 and other courses in Differential Equations and Modeling, Discrete Mathematics, Financial Mathematics, and Optimization and Computation.

Differential Equations and Modeling
>   MATH 520 – Ordinary Differential Equations
>   MATH 521 - Boundary Value Problems and Partial
>   Differential Equations
>   MATH 522 - Wavelets
>   MATH 523 - Mathematical Modeling of Population
>   Biology

Financial Mathematics and Probability
>   MATH 511 - Probability
>   MATH 514 - Financial Mathematics I
>   MATH 515 - Financial Mathematics II

Analysis
>   MATH 550 – Vector Analysis
>   MATH 552 – Applied Complex Variables
>   MATH 555 – Analysis II

Data Science
>   MATH 528 – Math Foundation of Data Science and
>   Machine Learning
>   MATH 572 – Mathematical Foundation of Network
>   Science

Discrete Mathematics
>   MATH 541 - Algebraic Coding Theory
>   MATH 548 – Geometry, Algebra, and Algorithms
>   MATH 570 - Discrete Optimization
>   MATH 574 – Discrete Mathematics
>   MATH 575 - Discrete Mathematics II
>   MATH 576 - Combinatorial Game Theory
>   MATH 587 - Introduction to Cryptography

Optimization and Computation
>   MATH 524 - Nonlinear Optimization
>   MATH 544L – Linear Algebra Laboratory
>   MATH 527 - Numerical Analysis
>   MATH 570 - Discrete Optimization

4. Mathematics Internship

Mathematics majors who have completed 60 credit hours with a 3.0 GPA or better are eligible to enroll in MATH 490 to obtain academic credit along with an internship. This is a variable credit, pass-fail course that is closely tied to an off campus job that has a strong connection to mathematics and its applications. Work can be done on a part-time basis during the semester, or on a full time basis in the summer or during the winter break. Job opportunities can be found with the Internship Office in the Career Center. Information about the individualized contract that establishes the requirements of the course can be obtained from the Undergraduate Director. The student may select a faculty member for supervision of the course or ask for the Undergraduate Director to select one. An internship can be one component in earning a degree with Leadership Distinction through the Carolina Connect program.

5. Cognates, Minors, Double Majors and Dual Degrees

COGNATES

The cognate consists of 12 hours of upper-division courses selected in consultation with, and approved by, your advisor. Mathematics majors may satisfy this requirement by passing 12 credit hours of cognate eligible courses offered by the College of Arts and Sciences or Department of Computer Science and Engineering. Cognates selected from other disciplines should be supportive of the major and must be in <u>one field</u> selected with and approved by the student's academic advisor. If a discipline is not supportive of the major, then the student should pursue a minor in that subject area. The Undergraduate Director must approve all exceptions in advance. See <u>here</u> for the list of departments and courses that are accepted for cognate credit.

DOUBLE MAJORS AND DUAL DEGREES

Instead of selecting a cognate (12 hours) or a minor (18 hours), some students complete a second major. If the second discipline is in the College of Arts and Sciences, or Computer Science (in the College of Engineering and Computing), they will graduate with double majors.

Students interested in other combinations of degrees must pursue dual degrees. This means that students must satisfy all requirements for each degree. The same courses can be applied towards the Carolina Core Plus requirements for each degree; no course may be counted towards the Major Requirements for more than one degree, except that MATH/STAT 511 can be used to fulfill a major requirement for both Mathematics and Statistics.

Double majors and dual degrees must be approved by the Dean and usually can be accommodated within the required 120-hours if the decision is made reasonably early, say in the second year. The most common double majors are Mathematics and Statistics and Mathematics and Computer Science.

MINORS

You may replace the cognate with a minor if you so desire. The minor consists of a minimum of eighteen hours of coursework instead of the twelve needed for the cognate. The minor is also more structured. All courses in the minor must be passed with grades of C or better and at least half of the courses must be in residence at USC. Students who are planning to minor in a subject area need to go to the Dean's office and fill out the appropriate forms to declare the minor.

Four minors that are popular with mathematics majors are as follows:

- **Minor in Risk Management and Insurance**
  1. Prerequisite Course (3 hrs)
     a) ECON 221
  2. Required Courses: (18 hrs)
     a) ACCT 225
     b) ECON 222
     c) FINA 363, FINA 469, FINA 471, FINA 475
  3. Additional courses of interest may include
     FINA 341, FINA 442, FINA 443, FINA 444, FINA 445
     Note that FINA 469 is a prerequisite for FINA 475.

- **Minor in Education**
  1. EDFI 300, EDPY 401, EDSE 302, and EDSE 500
  Two courses (6 credit hours) chosen from your area of educational specialization.
  This combination of courses is recommended for optimal preparation for the MT in Secondary Education.

- **Minor in Statistics**
  1. Required Courses: Eighteen (18) credit hours of 500-level STAT courses.
     Only one of STAT 509 and STAT 515 may be counted for minor credit.

- **[Minor in Computer Science](#)**
  1. Required Foundation Courses: (8 hrs): CSCE 145 and 146
  2. Intermediate Level Courses (6 hrs): Two of the following courses: CSCE 201, 210, 211, 212, 240, and 242
     Note: CSCE 211 is prerequisite for CSCE 212 and CSCE 210 is a less intensive introduction to computer hardware than the CSCE 211/212 sequence.
  3. Advanced Courses (6 hrs): Any two CSCE courses at the 300 level or above with the exception of CSCE 500.
     Note that some CSCE courses have MATH or STAT prerequisites.

6. Electives

Requirements for the baccalaureate degree in the College of Arts and Sciences include at least 120 hours in academic subjects. Students in the College of Arts and Sciences may elect acceptable courses offered in other colleges of the University. Elective credits for participation in the University chorus, orchestra, or band may be counted up to a maximum of 4 credits.

7. Honors Courses

Honors sections of the calculus courses (141, 142, and 241), are offered every Fall and Spring semester. Honors section of other courses, MATH 544, 546, 547, 550, 554, 555, 574, and either 575 or 576, are offered once each academic year. Honors MATH courses are available to highly qualified students regardless whether they are in the South Carolina Honors College. Non-Honors College students must receive approval from the Undergraduate Director prior to being permitted to register for an honors MATH course; complete the **[application](#)** prior to registration.

DESCRIPTIONS OF UNDERGRADUATE MATHEMATICS COURSES

111 **Basic College Mathematics. (3)** (Prereq: placement through Algebra version of the Mathematics Placement Test   Basic college algebra; linear and quadratic equations, inequalities, functions and graphs of functions, exponential and logarithm functions, systems of equations.

111I **Intensive Basic College Mathematics. (4)** (Prereq: placement through Algebra version of the Mathematics Placement Test   An intensive treatment of the topics covered in MATH 111. Basic college algebra; linear and quadratic equations, inequalities, functions and graphs of functions, exponential and logarithm functions, systems of equations.

112 **Trigonometry. (2)** (Prereq: C or better in MATH 111 or 111I, or placement through Algebra version of the Mathematics Placement Test Topics in trigonometry specifically needed for MATH 141, 142, 241. Circular functions, analytic trigonometry, applications of trigonometry.

115 **Precalculus Mathematics. (4)** (Prereq: C or better in MATH 111 or 111I, or placement through Precalculus version of the Mathematics Placement Test Topics in algebra and trigonometry specifically needed for MATH 141, 142, 241. Subsets of the real line, absolute value; polynomial, rational, inverse, logarithmic, exponential functions; circular functions; analytic trigonometry.

116 **Brief Precalculus Mathematics. (2)** (Prereq: C or better in MATH 112 or 115 or placement through Precalculus version of the Mathematics Placement Test Essential algebra and trigonometry topics for Calculus, including working with equations that involve polynomials, rational functions, exponential and logarithmic functions, and trigonometric and inverse trigonometric functions. Intended for students with prior experience in Precalculus, but not ready for MATH 141.

122 **Calculus for Business Administration and Social Sciences. (3)** (Prereq: C or better in MATH 111/111I, or 115, or by placement through Algebra version of the Mathematics Placement Test Derivatives and integrals of elementary algebraic, exponential, and logarithmic functions. Maxima, minima, rate of change, motion, work, area under a curve, and volume. Note: Carolina Core ARP

141 **Calculus I. (4)** (Prereq: C or better in MATH 112, 115, 116, or placement through Precalculus version of the Mathematics Placement Test Functions, limits, derivatives, introduction to integrals, the Fundamental

Theorem of Calculus, applications of derivatives and integrals. Notes: Four classroom hours and one laboratory hour per week. Note: Carolina Core ARP

142   **Calculus II. (4)** (Prereq: **C** or better in MATH 141) Four classroom hours and one laboratory hour per week. Methods of integration, sequences and series, approximations. Notes: Four classroom hours and one laboratory hour per week. Note: Carolina Core ARP

151   **Calculus Workshop I. (2)** (Prereq: Concurrent registration in MATH 141) Small study group practice in applications of calculus. For elective credit only. Note: Two 2-hour sessions per week.

152   **Calculus Workshop II. (2)** (Prereq: Concurrent registration in MATH 142) Small study group practice in applications of calculus. For elective credit only. Note**:** Two 2-hour sessions per week.

170   **Finite Mathematics. (3)** (Prereq: C or better in MATH 111 or 111I or 122, or by placement through Algebra version of the Mathematics Placement Test Elementary matrix theory; systems of linear equations; permutations and combinations; probability and Markov chains; linear programming and game theory. Note: Carolina Core ARP

172   **Mathematical Modeling for the Life Sciences. (3)**   (Prereq: C or better in MATH 122 or MATH 141) Modeling population growth and structure using difference equations, differential equations, and matrix techniques. Emphasis on determining equilibria and stability or instability of these to analyze long term system behavior. Qualitative analysis using graphical and numerical techniques, analytical techniques used for linear and affine discrete and continuous models. Biological topics drawn from Malthusian exponential growth, logistic growth, Alee effects, predator-prey and competition interactions, age structured populations, allometric relationships, metapopulations and island biogeography, succession, Michaelis-Menton-Monod resource uptake and other functional responses. Note: Carolina Core ARP

174   **Discrete Mathematics for Computer Science. (3)** (Prereq: C or better in MATH 115, 116, 111, or 141, or placement through PreCalculus version of the Mathematics Placement Test Induction, complexity, elementary counting, combinations and permutations, recursion and recurrence relations, graphs and trees; discussion of the design and analysis of algorithms--with emphasis on sorting and searching. Note: Carolina Core ARP (pending)

198   **Introduction to Careers and Research in the Mathematical Sciences. (1)** (Prereq: C or better in MATH 141) An overview of different areas of mathematical research and career opportunities for mathematics majors. Pass/fail only

221   **Basic Concepts of Elementary Mathematics I. (3)** (Prereq: C or better in MATH 111/111I, or by placement through either version of the Mathematics Placement Test or consent of the Undergraduate Director) The meaning of number, fundamental operations of arithmetic, the structure of the real number system and its subsystems, elementary number theory. Open only to students in elementary or early childhood teacher certification.

222   **Basic Concepts of Elementary Mathematics II. (3)** (Prereq: grade of C or better in MATH 221, or consent of the Undergraduate Director) Informal geometry and basic concepts of algebra. Open only to students in elementary or early childhood teacher certification.

241   **Vector Calculus. (3)** (Prereq: **C** or better in MATH 142, or consent of the Undergraduate Director) Vector algebra, geometry of three-dimensional space; lines, planes, and curves in space; polar, cylindrical, and spherical coordinate systems; partial differentiation, max-min theory; multiple and iterated integration, line integrals, and Green's theorem in the plane.

242   **Elementary Differential Equations. (3)** (Prereq **C** or better in MATH 142 or consent of the Undergraduate Director) Ordinary differential equations of first order, higher order linear equations, Laplace transform methods, series methods; numerical solution of differential equations. Applications to physical sciences and engineering.

300   **Transition to Advanced Mathematics. (3)** (Prereq: C or better in MATH 142 or consent of the Undergraduate Director) Rigor of mathematical thinking and proof writing via logic, sets, and functions. Intended to bridge the gap between lower-level (computational-based) and upper-level (proof-based) mathematics courses.

344   **Applied Linear Algebra. (3)** (Prereq: C or better in Math 142 or consent of Undergraduate Director) General solutions of systems of linear equations, vector spaces and subspaces, linear transformations, determinants, orthogonality, characteristic polynomials, eigenvalues and eigenvectors, singular value decompositions, and generalized inverse. Note: Math 344L is an optional laboratory course where additional applications will be discussed.

344L   **Applied Linear Algebra Lab. (1)** (Prereq or coreq: C or better or concurrent enrollment in Math 344) Computer based applications of linear algebra for science and engineering students. Topics include numerical analysis of matrices, direct and indirect methods for solving linear systems, and least squares method (regression). Typical applications include practical issues related to discrete Markov processes, image compression, and linear programming. Note: Credit not allowed for both Math 344L and 544L.

374   **Discrete Structures. (3)** (Prereq: C or better in both MATH 142 and CSCE 146) Propositional and predicate logic; proof techniques; recursion and recurrence relations; sets, combinatorics, and probability; functions, relations, and matrices; algebraic structures.

399   **Independent Study. (3-9)** Contract approved by instructor, advisor, and department chair is required for undergraduate students.

401   **Conceptual History of Mathematics. (3)** (Prereq: C or better in MATH 122, or 141, or consent of the Undergraduate Director) Topics from the history of mathematics emphasizing the 17th century to the present. Various mathematical concepts are discussed and their development traced. For elective credit only.

490   **Mathematics Internship. (1-3)** (Prereq: C or better in MATH 241, 300, and at least one 500 level Math course; completion of CSCE 145 or 206 and one of STAT 509, 512, 515). Academic counterpart to a professional work experience in which mathematics plays a central role. Introduction to the uses of problem formulation and problem solving in a working environment. Introduction to career possibilities for a student trained in mathematics. Notes: (1) restricted to math majors with a GPA of 3.0 or better and completion of at least 60 credit hours, (2) Pass/Fail only, (3) may be repeated up to 4 times for a maximum of 6 credit hours.

499   **Undergraduate Research. (1-3)** Research on a specific mathematical subject area. The specific content of the research project must be outlined in a proposal that must be approved by the instructor and the Undergraduate Director. Intended for students pursuing the B.S. in Mathematics with Distinction (Pass-Fail grading only.)

511   **Probability. {= STAT 511} (3)** (Prereq: C or higher or concurrent enrollment in MATH 241 or consent of the Undergraduate Director) Probability and independence; discrete and continuous random variables; joint, marginal, and conditional densities, moment generating functions; laws of large numbers; binomial, Poisson, gamma, univariate, and bivariate normal distributions.

514   **Financial Mathematics I. {=STAT 522} (3)** (Prereq: **C** or better in MATH 241 or consent of Undergraduate Director) Probability spaces. Random variables. Mean and variance. Geometric Brownian Motion and stock price dynamics. Interest rates and present value analysis. Pricing via arbitrage arguments. Options pricing and the Black-Scholes formula.

515   **Financial Mathematics II. {=STAT 523} (3)** (Prereq: C or better in MATH 514 or STAT 522; or consent of the Undergraduate Director) Convex sets. Separating Hyperplane Theorem. Fundamental Theorem of Asset Pricing. Risk and expected return. Minimum variance portfolios. Capital Asset Pricing Model. Martingales and options pricing. Optimization models and dynamic programming.

520   **Ordinary Differential Equations. (3)** (Prereq: C or better in MATH 344 or 544; or consent of the Undergraduate Director) Differential equations of the first order, linear systems of ordinary differential equations, elementary qualitative properties of nonlinear systems.

521   **Boundary Value Problems and Partial Differential Equations. (3)** (Prereq: C or better in MATH 520 or in both 241 and 242 or consent of Undergraduate Director) Laplace transforms, two-point boundary value problems and Green's functions, boundary value problems in partial differential equations, eigenfunction expansions and separation of variables, transform methods for solving PDE's, Green's functions for PDE's, and the method of characteristics.

522 Wavelets. (3) (Prereq: C or better in MATH 344 or 544 or consent of Undergraduate Director) Basic principles and methods of Fourier transforms, wavelets, and multiresolution analysis; applications to differential equations, data compression, and signal and image processing; development of numerical algorithms. Computer implementation.

523 Mathematical Modeling of Population Biology. (3) (Prereq: C or better in MATH 142, BIOL 301, or MSCI 311 recommended) Applications of differential and difference equations and linear algebra modeling the dynamics of populations, with emphasis on stability and oscillation. Critical analysis of current publications with computer simulation of models.

524 Nonlinear Optimization. (3) (Prereq: C or better in MATH 241and one of MATH 344 or MATH 544 or consent of the Undergraduate Director) Descent methods, conjugate direction methods, and Quasi-Newton algorithms for unconstrained optimization; globally convergent hybrid algorithm; primal, penalty, and barrier methods for constrained optimization. Computer implementation of algorithms.

525 Mathematical Game Theory. (3) (Prereq: C or better in MATH 544 or in both MATH 300 and 344, or consent of the Undergraduate Director) Two-person zero-sum games, minimax theorem, utility theory, n-person games, market games, stability.

527 Numerical Analysis. {=CSCE 561} (3) (Prereq: C or better in MATH 520 or in both MATH 242 and 344, or consent of the Undergraduate Director) Interpolation and approximation of functions; solution of algebraic equations; numerical differentiation and integration; numerical solutions of ordinary differential equations and boundary value problems; computer implementation of algorithms.

528 Mathematical Foundation of Data Science and Machine Learning (3) (Prereq: C or better in MATH 344 or 544, or consent of the Undergraduate Director) Unconstrained and constrained optimization, gradient descent methods for numerical optimization, supervised and unsupervised learning, various reduced order methods, sampling and inference, Monte Carlo methods, deep neural networks.

531 Foundations of Geometry. (3) (Prereq: C or better in MATH 300 or consent of the Undergraduate Director) The study of geometry as a logical system based upon postulates and undefined terms. The fundamental concepts and relations of Euclidean geometry developed rigorously on the basis of a set of postulates. Some topics from non-Euclidean geometry.

532 Modern Geometry. (3) (Prereq: C or better in MATH 300 or consent of the Undergraduate Director) Projective geometry, theorem of Desargues, conics, transformation theory, affine geometry, Euclidean geometry, non-Euclidean geometries, and topology.

533 Elementary Geometric Topology. (3) (Prereq: C or better in MATH 241 and MATH 300 or consent of the Undergraduate Director) Topology of the line, plane, and space, Jordan curve theorem, Brouwer fixed point theorem, Euler characteristic of polyhedra, orientable and non-orientable surfaces, classification of surfaces, network topology.

534 Elements of General Topology. (3) (Prereq: C or better in MATH 241 and MATH 300 or consent of the Undergraduate Director) Elementary properties of sets, functions, spaces, maps, separation axioms, compactness, completeness, convergence, connectedness, path connectedness, embedding and extension theorems, metric spaces, and compactification.

540 Modern Applied Algebra. (3) (Prereq: C or better in MATH 300 or consent of the Undergraduate Director) Finite structures useful in applied areas. Binary relations, Boolean algebras, applications to optimization, and realization of finite state machines.

541 Algebraic Coding Theory. (3) (Prereq: C or better in MATH 544 or in both MATH 300 and 344 or consent of the Undergraduate Director) Error-correcting codes, polynomial rings, cyclic codes, finite fields, BCH codes.

544 Linear Algebra. (3) (Prereq: C or better in MATH 241 and MATH 300, or consent of Undergraduate Director) Vectors, vector spaces, and subspaces; geometry of finite dimensional Euclidean space; linear transformations; eigenvalues and eigenvectors; diagonalization. Throughout there will be an emphasis on theoretical concepts, logic, and methods. Note: MATH 544L is an optional laboratory course where additional applications will be discussed.

544L **Linear Algebra Lab (1) {=MATH 344L}** (Prereq or coreq: C or better or concurrent enrollment in MATH 544). Objectives include acquainting mathematics students with the capabilities of computers for solving linear algebra-based problems that arise in their professions and providing students an opportunity to develop their programming and problem solving skills. Topics include numerical analysis of matrices, direct and indirect methods for solving linear systems, and least squares method (regression). Applications include discrete Markov processes and linear programming. Credit not allowed for both MATH 344L and 544L.

546 **Algebraic Structures I. (3)** (Prereq: C or better in MATH 544 or consent of the Undergraduate Director) Permutation groups; abstract groups; introduction to algebraic structures through study of subgroups, quotient groups, homomorphisms, isomorphisms, direct product; decompositions; introduction to rings and fields.

547 **Algebraic Structures II. (3)** (Prereq: C or better in MATH 546 or consent of the Undergraduate Director) Rings, ideals, polynomial rings, unique factorization domains; structure of finite groups; topics from: fields, field extensions, Euclidean constructions, modules over principal ideal domains (canonical forms).

548 **Geometry, Algebra, and Algorithms (3)** (Prereq: C or better in MATH 300 and in one of MATH 344 or MATH 544, or consent of the Undergraduate Director). Polynomials and affine space, Groebner bases, elimination theory, varieties, and computer algebra systems.

550 **Vector Analysis. (3)** (Prereq: C or higher in MATH 241 or consent of the Undergraduate Director) Vector fields, line and path integrals, orientation and parametrization of lines and surfaces, change of variables and Jacobians, oriented surface integrals, theorems of Green, Gauss, and Stokes; introduction to tensor analysis.

551 **Introduction to Differential Geometry. (3)** (Prereq: C or better in MATH 241 and MATH 300 or consent of Undergraduate Director) Parametrized curves, regular curves and surfaces, change of parameters, tangent planes, the differential of a map, the Gauss map, first and second fundamental forms, vector fields, geodesics, and the exponential map.

552 **Applied Complex Variables. (3)** (Prereq: C or better in MATH 241 or consent of Undergraduate Director) Complex integration, calculus of residues, conformal mapping, Taylor and Laurent Series expansions, applications.

554 **Analysis I. (3)** (Prereq: C or better in MATH 241 and two 500-level courses requiring MATH 300: MATH 525, MATH 531, MATH532, MATH 533, MATH 534, MATH 540, MATH 541, MATH 544, MATH 546, MATH 548, MATH 551, MATH 561, MATH 570, MATH 574, MATH 575, or MATH 580. Least upper bound axiom, the real numbers, compactness, sequences, continuity, uniform continuity, differentiation, Riemann integral and fundamental theorem of calculus. Note: Carolina Core Integrative Course, Mathematics, BS

555 **Analysis II. (3)** (Prereq: C or better in MATH 554 or consent of the Undergraduate Director) Riemann-Stieltjes integral, infinite series, sequences and series of functions, uniform convergence, Weierstrass approximation theorem, selected topics from Fourier series or Lebesgue integration.

561 **Introduction to Mathematical Logic. (3)** (Prereq: C or better in MATH 300 or consent of Undergraduate Director) Syntax and semantics of formal languages; sentential logic, proofs in first order logic; Godel's completeness theorem; compactness theorem and applications; cardinals and ordinals; the Lowenheim-Skolem-Tarski theorem; Beth's definability theorem; effectively computable functions; Godel's incompleteness theorem; undecidable theories.

562 **Theory of Computation. {=CSCE 551} (3)** (Prereq: C or better in CSCE 350 or MATH 300 or consent of the Undergraduate Director) Basic theoretical principles of computing as modeled by formal languages and automata; computability and computational complexity. Major credit may not be received for both CSCE 355 and CSCE 551.

570 **Discrete Optimization. (3)** (Prereq: C or better in MATH 300 and in one of MATH 344 or MATH 544 or consent of the Undergraduate Director) Discrete mathematical models. Applications to such problems as resource allocation and transportation. Topics include linear programming, integer programming, network analysis, and dynamic programming.

572 **Mathematical Foundation of Network Science (3)** (Prereq: C or better in MATH 374 or in one of MATH 344 or MATH 544, or consent of the Undergraduate Director) Graphs and probability, Web graphs, random graphs, models for complex graphs, graph searching algorithms, eigenvalues, PageRank.

574 Discrete Mathematics I. (3) (Prereq: C or better in MATH 300 or consent of the Undergraduate Director) Mathematical models; mathematical reasoning; enumeration; induction and recursion; tree structures; networks and graphs; analysis of algorithms.

575 Discrete Mathematics II. (3) (Prereq: C or better in MATH 574 or consent of the Undergradute Director) A continuation of MATH 574. Inversion formulas; Polya counting; combinatorial designs; minimax theorems; probabilistic methods; Ramsey theory; other topics.

576 Combinatorial Game Theory. (3) (Prereq: C or better MATH 300 or MATH 374 or consent of the Undergraduate Director) Winning in certain combinatorial games such as Nim, Hackenbush, and domineering. Equalities and inequalities among games, Sprague-Grundy theory of impartial games, games which are numbers.

580 Elementary Number Theory. (3) (Prereq: C or better in MATH 300 or consent of the Undergraduate Director) Divisibility, primes, congruences, quadratic residues, numerical functions. Diophantine equations.

587 Introduction to Cryptography. {=CSCE 557} (3) (Prereq: C or better in CSCE 145 or MATH 241, and at least one of CSCE 355, MATH 300, or MATH 374 or consent of the Undergraduate Director) Design of secret codes for secure communication, including encryption and integrity verification: ciphers, cryptographic hashing, and public key cryptosystems such as RSA. Mathematical principles underlying encryption. Code-breaking techniques. Cryptographic protocols.

590 Undergraduate Seminar. (1-3) (Prereq: consent of instructor) A review of literature in specific subject areas involving student presentations. Content varies and will be announced in the *Master Schedule of Classes* by suffix and title. Pass-fail grading. For undergraduate credit only.

599 Topics in Mathematics. (1-3) Recent developments in pure and applied mathematics selected to meet current faculty and student interest.

602 An Inductive Approach to Geometry. (3) (Prereq: C or better in MATH 122 or 141 or equivalent, or consent of the Undergraduate Director) This course is designed for middle level pre-service mathematics teachers. This course covers geometric reasoning, Euclidean geometry,

603 Inquiry Approach to Algebra. (3) (Prereq: C or higher in MATH 122 or MATH 141 or equivalent, or consent of the Undergraduate Director) This course introduces basic concepts in number theory and modern algebra that provide the foundation for middle level arithmetic and algebra. Topics include: algebraic reasoning, patterns, inductive reasoning, deductive reasoning, arithmetic and algebra of integers, algebraic systems, algebraic modeling, and axiomatic mathematics. This course cannot be used for credit towards a major or minor in mathematics.

650 AP Calculus for Teachers (3) (Prereq: current secondary high school teacher certification in mathematics and a C or better in at least 6 hours of calculus or consent of the Undergraduate Director) A thorough study of the topics to be presented in AP calculus, including limits of functions, differentiation, integration, infinite series, and applications. (Not intended for degree programs in mathematics.)

PLANNING YOUR DEGREE PROGRAM

Schedule of Regularly-Offered Upper-Division MATH Courses

Course	Fall (odd)	Spring (even)	Summer (even)	Fall (even)	Spring (odd)	Summer (odd)
300	X + H	X + H		X + H	X + H	
344	X	X		X	X	
374	X	X		X	X	
511	*X*	*X*	*X*	*X*	*X*	*X*
514	X			X		
515		X				
520	*X*	*X* + H		*X*	*X* + H	
521					X	
522				X		
524	X					
527		X				
531	X			X		
532		X			X	
534	*X*					
544	X	X + H	X	X	X + H	X
546	X	X		X + H	X	
547		H			H	
550	*X*	*X* + *H*		*X*	*X* + *H*	
552		*X*			*X*	
554	X + H	X		X	X	
555		H				
570				X		
574	X + H	X	X	X + H	X	
580	X			X		X

Legend:	
H	Registration in Honors sections is controlled by the SC Honors College. Non-Honors students can request permission to enroll in Honors sections through your math advisor
bold	required for all Mathematics majors
italics	*one of these courses is required – before taking MATH 554*

Notes:
1. The Department makes every effort to run these courses as listed, but whether a course runs in each of the indicated semesters depends upon enrollment and staffing.
2. MATH 523, 525, 528, 533, 540, 541, 548, 551, 561, 562, 572, 575, 576 and 587 are offered on an irregular basis depending upon demand and faculty availability.

Individual Program of Study for
B. S. in Mathematics

Major Pathway: __ General ___   Cognate/Minor: _____

	Fall Semester	Role	Hrs	Spring Semester	Role	Hrs	Total Hrs
Freshman	MATH 141	ARP - CC	4	MATH 142	ARP - CC	4	
	ENGL 101	CMW - CC	3	ENGL 102	CMW+INF - CC	3	
	Lab Science	SCI - CC	4	Lab Science	SCI - CC	4	
	HIST 10x / 11x	GHS - CC	3	HIST 11x / 10x	GHS - CC	3	
	UNIV 101	Elective	3	Humanity / Fine Art	AIU - AS	3	
	Semester Total		17			17	34
							34
Sophomore	MATH 241	Pre-Major	3	MATH 544	Major Core	3	
	MATH 300	Pre-Major	3	MATH 5xx	Major Elec	3	
	For Lang 121	GFL - CC	4	For Lang 122	GFL - CC	3	
	Social Science	GSS - CC	3	Social Science	GSS - AS	3	
	CSCE 145 / 206	ARP - AS	4	SPCH 140	CMS - CC	3	
	Semester Total		17			15	32
							66
Junior	MATH 511 / 520 / 534 / 550	Major Core	3	MATH 546 / 554	Major Core	3	
	MATH 5xx	Major Elec	3	STAT 509 / 512 / 515	ARP - AS	3	
	Fine Art / Lit	AIU - CC	3	Val, Eth, Soc Resp	VSR - CC	3	
	Cognate / Minor		3	Cognate / Minor		3	
	Elective		3	Elective		3	
	Semester Total		15			15	30
							96
Senior	MATH 546 / 554	Major Core	3	MATH 5xx	Major Elec	3	
	MATH 5xx	Major Elec	3	Cognate / Minor		3	
	Cognate / Minor		3	Minor / Elective		3	
	Minor / Elective		3	Elective		3	
	Elective		3	Elective		3	
	Semester Total		15			15	30
							126

Individual Program of Study for
B. S. in Mathematics

Major Pathway: __ Education ___   Cognate/Minor: _ Secondary Education _

	Fall Semester	Role	Hrs	Spring Semester	Role	Hrs	Total Hrs
Freshman	MATH 141	ARP - CC	4	MATH 142	ARP - CC	4	
	ENGL 101	CMW - CC	3	ENGL 102	CMW+INF - CC	3	
	Lab Science	SCI - CC	4	Lab Science	SCI - CC	4	
	HIST 10x / 11x	GHS - CC	3	HIST 11x / 10x	GHS - CC	3	
	UNIV 101	Elective	3	Humanity / Fine Art	AIU - AS	3	
	Semester Total		17			17	34
							34
Sophomore	MATH 241	Pre-Major	3	MATH 544	Major Core	3	
	MATH 300	Pre-Major	3	MATH 5xx	Major Elec	3	
	For Lang 121	GFL - CC	4	For Lang 122	GFL - CC	3	
	Social Science	GSS - CC	3	SPCH 140	CMS - CC	3	
	EDFI 300	Cognate	3	EDPY 401	Cognate	3	
	Semester Total		16			15	31
							65
Junior	MATH 511 / 520 / 534 / 550	Major Core	3	MATH 546 / 554	Major Core	3	
	MATH 580	Major Elec	3	STAT 509 / 512 / 515	ARP - AS	3	
	Fine Art / Lit	AIU - CC	3	Val, Eth, Soc Resp	VSR - CC	3	
	CSCE 145 / 206	ARP - AS	4	Social Science	GSS - AS	3	
	EDSE 302	Cognate	3	EDSE 500	Cognate	3	
	Semester Total		16			15	31
							96
Senior	MATH 546 / 554	Major Core	3	MATH 5xx / 532	Major Elec	3	
	MATH 531 / 5xx	Major Elec	3	Minor / Elective		3	
	Minor / Elective		3	Elective		3	
	Elective		3	Elective		3	
	Elective		3	Elective		3	
	Semester Total		15			15	30
							126

Individual Program of Study for

B. S. in Mathematics

Major Pathway: __ Actuarial ___   Cognate/Minor: _ Risk Mgmt & Ins _

	Fall Semester	Role	Hrs	Spring Semester	Role	Hrs	Total Hrs
Freshman	MATH 141	ARP - CC	4	MATH 142	ARP - CC	4	
	ENGL 101	CMW - CC	3	ENGL 102	CMW+INF - CC	3	
	Lab Science	SCI - CC	4	Lab Science	SCI - CC	4	
	HIST 10x / 11x	GHS - CC	3	HIST 11x / 10x	GHS - CC	3	
	UNIV 101	Elective	3	ACCT 225	Minor	3	
	Semester Total		17			17	34
							34
Sophomore	MATH 241	Pre-Major	3	MATH 300	Pre-Major	3	
	MATH 511	Major Core	3	STAT 512	ARP - AS	3	
	For Lang 121	GFL - CC	4	For Lang 122	GFL - CC	3	
	ECON 221	GSS – A / Minor / VEES	3	ECON 222	Minor / SOA-VEE	3	
	Fine Art / Lit	AIU - CC	3	CSCE 145 / 206	ARP - AS	4	
	Semester Total		16			16	32
							66
Junior	MATH 544	Major Core	3	MATH 546 / 554	Major Core	3	
	MATH 5xx	Major Elec	3	MATH 5xx	Major Elec	3	
	STAT 513	Elective	3	SPCH 140	CMS - CC	3	
	FINA 363	Minor / SOA-VEE	3	ECON 436	SOA - VEE	3	
	Humanity / Fine Art	AIU - AS	3	FINA 469	Minor	3	
	Semester Total		15			15	30
							96
Senior	MATH 524 / 570	Major Elec	3	MATH 554 / 546	Major Core	3	
	MATH 5xx	Major Elec	3	FINA 475	Minor	3	
	FINA 471	Minor	3	CSCE 146/STAT 540	SoA-VEE	3	
	Val, Eth, Soc Resp	VSR - CC	3	Elective		3	
	Social Science	GSS - CC	3	Elective		3	
	Semester Total		15			15	30
							126

Individual Program of Study for
B. S. in Mathematics

Major Pathway: __ Applied ___   Cognate/Minor: _____

	Fall Semester	Role	Hrs	Spring Semester	Role	Hrs	Total Hrs
Freshman	MATH 141	ARP - CC	4	MATH 142	ARP - CC	4	
	ENGL 101	CMW - CC	3	ENGL 102	CMW+INF - CC	3	
	Lab Science	SCI - CC	4	Lab Science	SCI - CC	4	
	HIST 10x / 11x	GHS - CC	3	HIST 11x / 10x	GHS - CC	3	
	UNIV 101	Elective	3	Humanity / Fine Art	AIU - AS	3	
	Semester Total		17			17	34
							34
Sophomore	MATH 241	Pre-Major	3	MATH 544	Major Core	3	
	MATH 300	Pre-Major	3	MATH 544L	Major Elec	1	
	For Lang 121	GFL - CC	4	MATH 5xx	Major Elec	3	
	Social Science	GSS - CC	3	For Lang 122	GFL - CC	3	
	CSCE 145 / 206	ARP - AS	4	Social Science	GSS - AS	3	
				SPCH 140	CMS - CC	3	
	Semester Total		17			16	33
							67
Junior	MATH 511 / 520 / 534 / 550	Major Core	3	MATH 546 / 554	Major Core	3	
	MATH 5xx	Major Elec	3	STAT 509 / 512 / 515	ARP - AS	3	
	Fine Art / Lit	AIU - CC	3	Val, Eth, Soc Resp	VSR - CC	3	
	Cognate / Minor		3	Cognate / Minor		3	
	Elective		3	Elective		3	
	Semester Total		15			15	30
							97
Senior	MATH 554 / 546	Major Core	3	MATH 5xx	Major Elec	3	
	MATH 5xx	Major Elec	3	Cognate / Minor		3	
	Cognate / Minor		3	Minor / Elective		3	
	Minor / Elective		3	Elective		3	
	Elective		3	Elective		3	
	Semester Total		15			15	30
							127

Graduation Checklist for B.S. in Mathematics (2019-2020)

	Course	Credit Hrs	Grade	Note
Effective & Persuasive Communication: Writing	ENGL 101			CMW - CC
	ENGL 102			CMW - CC
Analytical Reasoning & Problem Solving	MATH 141			ARP - CC
	MATH 142			ARP - CC
STAT 509, 512, or 515	STAT			ARP - AS
CSCE 145 or 206	CSCE			ARP - AS
Scientific Literacy				SCI - CC
				SCI - CC
2 lab sequences (8 hrs)				SCI - CC
				SCI - CC
Global Citizenship: Foreign Language				GFL - CC
				GFL - CC
thru 122 (0-9 hrs)				GFL - CC
Global Citizenship: Historical Thinking	HIST 10_			GHS - CC
	HIST 11_			GHS - CC
Global Citizenship: Social Science				GSS - CC
				GSS - AS
Fine Arts / Literature Humanity / Fine Arts				AIU - CC
				AIU - AS
*Comm: Speech				CMS - CC
*Information Literacy				INF - CC
*Values, Ethics, Soc Resp				VSR - CC

* 2 of CMS, INF, and VSR can be overlays
total hrs depends on GFL & overlays

Hrs Earned	0
Hrs Req'd	53 -- 68

	Course	Credit Hrs	Grade
Pre-Major	MATH 241		
	MATH 300		

Hrs Earned	0
Hrs Req'd	6

	Course	Credit Hrs	Grade
Major	MATH 544		
	MATH 511, 520, 534, 550, or 552		
	MATH 546		
	MATH 554		
	MATH 5__		
	MATH 5__		
	MATH 5__		
	MATH 5__		

Hrs Earned	0
Hrs Req'd	24

	Course	Credit Hrs	Grade
Cognate, Minor, or 2ᵈ Major			

Hrs Earned	0
Hrs Req'd	12--18

	Course	Credit Hrs	Grade
Elective			

Hrs Earned	0
Hrs Req'd	3 -- 25

Total Hours Earned	0
Total Hours Req'd	120

DEPARTMENT OF MATHEMATICS MINOR
(effective 2017-2018 and beyond)

Prerequisite Courses (8 hours)
- Math 141 – Calculus I
- Math 142 Calculus II

Required Course (3 hours)
- Math 241 – Vector Calculus

Additional Courses (15 hours) selected from the following, of which at least 6 hours must be at the 500 level:
- Math 242 - Elementary Differential Equations
- Math 300 – Transition to Advanced Mathematics
- Math 344 – Applied Linear Algebra
- Math 374 – Discrete Structures
- Math courses at the 500 level

Notes:
- All courses for a minor must be completed with a C or better
- At most one of Math 374 and 574 may be used for minor credit
- At most one of Math 344, 526, and 544 may be used for minor credit
- Most of the math courses at the 500 level have a prerequisite of 300 and/or 344 (or 544, which implicitly assumes completion of 300). Students are therefore strongly urged to include one or both of Math 300, 344 in their minor program.
- Students with an interest in pure mathematics (algebra, analysis, discrete mathematics, geometry and topology, logic, mathematics education, and number theory) should take Math 300
- Students with an interest in applied and computational mathematics (differential equations and modeling, financial mathematics, numerical analysis, optimization) should take Math 344.
- Prospective minors are urged to consult with an advisor in the Department of Mathematics to plan a coherent program of study.