Mathematics (MAT)

Major and Minor in Mathematics

Department of Mathematics, College of Arts and Sciences

CHAIRPERSON: David Ebin  DIRECTOR OF UNDERGRADUATE STUDIES: Scott Sutherland  ASSISTANT TO THE CHAIR: Lucille Meci

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Minors of particular interest to students majoring in Mathematics: Applied Mathematics and Statistics (AMS), Computer Science (CSE), Economics (ECO), Physics (PHY)

Faculty

Michael Anderson, Professor, Ph.D., University of California, Berkeley: differential geometry.


Christopher Bishop, Professor, Ph.D., University of Chicago: Complex analysis.

Kingshook Biswas, Lecturer, Ph.D., University of California Los Angeles: Holomorphic dynamics, Riemann surfaces.

Sylvain Bonnot, Lecturer, Ph.D., Université de Provence, Marseille: Complex dynamics, Holomorphic dynamics, several complex variables.

Sebastian Casalaina-Martin, Simons Instructor, Ph.D., Columbia University: Algebraic geometry.

Mark de Cataldo, Assistant Professor, Ph.D., University of Notre Dame: Higher dimensional geometry.

Reza Chamanara, Lecturer, Ph.D., Graduate Center, CUNY: Moduli spaces, Kleinian groups, complex analysis.

Moira Chas, Lecturer, Ph.D., Universitat Autonoma de Barcelona: Topology and dynamical systems.

David Ebin, Professor, Ph.D., Massachusetts Institute of Technology: Global analysis; mathematics of continuum mechanics; partial differential equations.

Daryl Geller, Professor, Ph.D., Princeton University: Partial differential equations; harmonic analysis; several complex variables; Lie groups.

James Glimm, Distinguished Professor, Ph.D., Columbia University: Applied mathematics; numerical analysis; mathematical physics.

Detlef Gromoll, Professor, Ph.D., University of Bonn, Germany: Differential geometry.

Eric Harrelson, RTG Fellow, Ph.D., University of Minnesota: Algebraic topology, String field theory.

Xuhua He, Simons Instructor, Ph.D., Massachusetts Institute of Technology: Representation theory, Algebraic geometry.

C. Denson Hill, Professor, Ph.D., New York University: Partial differential equations; several complex variables.

Jerome Jenquin, RTG Fellow, Ph.D., University of Texas at Austin: Differential geometry.

Lowell Jones, Professor, Ph.D., Yale University: Topology; geometry.

Jeremy Kahn, Lecturer, Ph.D., University of California, Berkeley: Dynamical systems, complex analysis.

Ljudmilla Kamenova, Simons Instructor, Ph.D., Massachusetts Institute of Technology: Complex geometry.

Nadia Kennedy, Assistant Professor, Ed.D., Montclair State University: Mathematics education.

Marcus Khuri, Assistant Professor, Ph.D., University of Pennsylvania: Differential geometry, partial differential equations, and general relativity.

Alexander Kirillov, Jr., Associate Professor, Ph.D., Yale University: Representation theory; low dimensional topology; mathematical physics.

Valentina Kiritchenko, Simons Instructor, Ph.D., University of Toronto: Algebraic geometry.

Irwin Kra, Distinguished Service Professor, Ph.D., Columbia University: Complex analysis; Kleinian groups, Riemann surfaces; Teichmuller theory; applications to mathematical physics and number theory.


H. Blaine Lawson, Jr., Distinguished Professor, Ph.D., Stanford University: Differential geometry; topology; algebraic geometry.

Claude LeBrun, Professor, D. Phil, University of Oxford, England: Complex analysis; mathematical physics; differential geometry; algebraic geometry.

Krzystof Lipiec, Lecturer, Ph.D., University of Michigan: Complex dynamics; complex variables.

William Linch III, RTG Fellow, Ph.D., University of Maryland: Theoretical physics.

Mikhail Lyubich, Professor and Co-director of the Institute for Mathematical Sciences, Ph.D., Tashkent State University, former Soviet Union: Dynamical systems.

Igor Markovic, Associate Professor, Ph.D., Belgrade University: Teichmuller theory and hyperbolic geometry; harmonic maps between manifolds.

Dror Varolin, Assistant Professor, Ph.D., University of Wisconsin, Madison: Several complex variables, algebraic geometry, complex geometry, dynamical systems.
Mathematics is an essential element in a wide range of human activities. It is the language of the physical sciences, and as such is an indispensable tool in the formulation of the laws of nature. In the social and biological sciences, it plays an increasingly important role in modeling complicated, large-scale phenomena. In addition, mathematics has an aesthetic side: awareness of the possibility of elegance and beauty in mathematical arguments has been a significant feature of human culture throughout history. Today more mathematics is being done, and more needs to be done, than ever before.

The undergraduate course offerings in Mathematics allow students to set up individualized programs of study consistent with their academic interests and career plans. Students should consider majoring in Mathematics even if they do not plan to become mathematicians or teachers of mathematics. The training in abstract reasoning and problem-solving is an excellent foundation for many different careers, such as law, graduate health professions, and business. Completion of a major in Mathematics points to a thinking person.

Students are encouraged to explore the various branches of pure and applied mathematics, as well as other mathematically oriented disciplines, to gain both breadth of knowledge and insight into career options. Mathematics majors can use their training as the foundation for advanced professional study, leading to research and teaching in universities or research in industrial research laboratories; they can use it also in secondary school teaching. In industry, undergraduate training in mathematics is excellent preparation for the important task of liaison work between the technological arm of a company and its marketing arm. A major in Mathematics is particularly appropriate for work in computer applications, operations research, and actuarial science. Double majors in Mathematics and another field, such as physics, computer science, applied mathematics and statistics, or economics, are common and are encouraged.

The secondary teacher education option is designed for students planning a career teaching mathematics in a secondary school. This option is described in detail in the “Education and Teacher Certification” entry in the alphabetical listings of Approved Majors, Minors, and Programs.

The Department of Mathematics offers tutorial help to all undergraduate students in its 100-level courses in the Mathematics Learning Center. Since the Center’s staff consists of faculty and graduate students in mathematics as well as undergraduate tutors, students in more advanced courses can also find assistance there.

The Department encourages students to seek information and advice on appropriate mathematics courses, programs, and career goals. Professors in mathematics are available as advisors in the Undergraduate Mathematics Office to help with these matters. Advising hours can be obtained by calling the Department of Mathematics.

Courses Offered in Mathematics
See the Course Descriptions listing in this Bulletin for complete information.

MAP 101  Fundamentals of Arithmetic and Algebra
MAP 103  Proficiency Algebra
MAT 118-C  Mathematical Thinking
MAT 118-C  Overview of Calculus with Applications
MAT 123-C  Introduction to Calculus
MAT 125-C  Calculus A
MAT 126-C  Calculus B
MAT 127-C  Calculus C
MAT 130  Functions
MAT 131-C  Calculus I
MAT 132-C  Calculus II
MAT 141-C  Honors Calculus I
MAT 142  Honors Calculus II
MAT 160  Mathematical Problems and Games
MAT 171  Accelerated Single Variable Mathematics
MAT 200  Logic, Language and Proof
MAT 203  Calculus III with Applications
MAT 205  Calculus III
MAT 211  Introduction to Linear Algebra
MAT 260  Problem Solving in Mathematics
MAT 303  Calculus IV with Applications
MAT 305  Calculus IV
MAT 310  Linear Algebra
MAT 311  Number Theory
MAT 312  Applied Algebra
MAT 313  Abstract Algebra
MAT 316  Invitation to Modern Mathematics
MAT 318  Classical Algebra
MAT 319  Foundations of Analysis
MAT 320  Introduction to Analysis
MAT 322  Analysis in Several Dimensions
MAT 324  Real Analysis
MAT 331  Computer-Assisted Mathematical Problem Solving
MAT 336-H  History of Mathematics
MAT 341  Applied Real Analysis
MAT 342  Applied Complex Analysis
MAT 351  Differential Equations: Dynamics and Chaos
MAT 360  Geometric Structures
MAT 362  Differential Geometry of Surfaces
MAT 364  Topology and Geometry
MAT 371  Logic
MAT 373  Analysis of Algorithms
MAT 401  Seminar in Mathematics
MAT 402  Seminar in Mathematics
MAT 475  Undergraduate Teaching Practicum
MAT 487  Independent Study in Special Topics
MAT 495  Honors Thesis

Courses Offered in Mathematics Education
See the Course Descriptions listing in this Bulletin for complete information.

MAE 301  Foundations of Secondary School Mathematics
MAE 302  Methods and Materials for Teaching Secondary School Mathematics
MAE 311  Introduction to Methods of Teaching Secondary School Mathematics
MAE 312  Micro-Teaching
MAE 330  Technology in Mathematics Education
MAE 412  Issues in Teaching and Learning in Collegiate Mathematics
MAE 447  Directed Readings in Mathematics Education
MAE 451  Supervised Teaching—Middle School Level Grades 7-9
MAE 452  Supervised Teaching—High School Grades 10-12
MAE 454  Student Teaching Seminar

Sample Course Sequence for the Major in Mathematics

<table>
<thead>
<tr>
<th>Freshman</th>
<th>Fall</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Year Seminar 101</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>D.E.C. A</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>MAT 131 or 141 or 125*</td>
<td>3-4</td>
<td></td>
</tr>
<tr>
<td>D.E.C.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Elective</td>
<td>3</td>
<td></td>
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<tr>
<td>Total</td>
<td>16-17</td>
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<table>
<thead>
<tr>
<th>Spring</th>
<th>Credits</th>
</tr>
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<tbody>
<tr>
<td>First Year Seminar 102</td>
<td>1</td>
</tr>
<tr>
<td>D.E.C. A</td>
<td>3</td>
</tr>
<tr>
<td>MAT 132 or 142 or 171 or 126*</td>
<td>3-4</td>
</tr>
<tr>
<td>D.E.C.</td>
<td>3</td>
</tr>
<tr>
<td>Elective</td>
<td>3</td>
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<tr>
<td>Total</td>
<td>16-17</td>
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<table>
<thead>
<tr>
<th>Sophomore</th>
<th>Fall</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>MAT 203 or 205 or AMS 261</td>
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</tr>
<tr>
<td>MAT 211 or AMS 210</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>D.E.C.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>D.E.C.</td>
<td>3</td>
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<tr>
<td>Elective</td>
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<td></td>
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<tr>
<td>Total</td>
<td>15</td>
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<table>
<thead>
<tr>
<th>Spring</th>
<th>Credits</th>
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<tbody>
<tr>
<td>MAT 303 or 305 or AMS 361</td>
<td>3</td>
</tr>
<tr>
<td>MAT 331</td>
<td>3</td>
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<tr>
<td>D.E.C.</td>
<td>3</td>
</tr>
<tr>
<td>Elective</td>
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<td>Total</td>
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<table>
<thead>
<tr>
<th>Junior</th>
<th>Fall</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>MAT 312 or 313</td>
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<td></td>
</tr>
<tr>
<td>MAT 319 or 320</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>D.E.C.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>D.E.C.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Elective</td>
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<td></td>
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<tr>
<td>Total</td>
<td>15</td>
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<table>
<thead>
<tr>
<th>Spring</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAT 322 or 341 or 342 or 324</td>
<td>3</td>
</tr>
<tr>
<td>MAT 310</td>
<td>3</td>
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<tr>
<td>D.E.C.</td>
<td>3</td>
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<tr>
<td>Upper-Division electives</td>
<td>6</td>
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<tr>
<td>Total</td>
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<tr>
<th>Senior</th>
<th>Fall</th>
<th>Credits</th>
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<tr>
<td>Upper-Division MAT electives</td>
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<tr>
<td>D.E.C.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Elective</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td></td>
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<table>
<thead>
<tr>
<th>Spring</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper-Division MAT electives</td>
<td>9</td>
</tr>
<tr>
<td>Electives</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
</tr>
</tbody>
</table>

*Students who take MAT 125, 126 must also complete MAT 127.

Requirements for the Major in Mathematics (MAT)

The major in Mathematics leads to the Bachelor of Science degree. Every student majoring in Mathematics is expected to complete some form of a one-variable calculus sequence, which is a prerequisite for some of the courses listed below. Appropriate sequences at Stony Brook total 8 to 12 credits. Completion of the major requires 33 to 37 credits.

A. Mathematics and Mathematics-Related Courses
1. One course in multivariate calculus:
   MAT 203 or AMS 261 or MAT 205
   and one course in linear algebra:
   MAT 211 or AMS 210

2. Preparation in the language and logic of mathematics: this requirement can be met by either passing MAT 200 or by passing the MAT 200 challenge examination. (Note: the writing intensive course MAT 200 is a requirement for students in the Secondary Teacher Education Program.)

3. One course in differential equations:
   MAT 303 or AMS 361 or MAT 305

4. One course in computer literacy:
   MAT 331 or MEC 111 or CSE 114 or
   (for students graduating with the Secondary Teacher Education option) MAE 330.

   Note: MAT 331 and MAE 330 may be used both here and in Requirement 7.

5. Two courses in algebra:
MAT 310 and
MAT 312 or 313 or 318

6. Analysis
Students must satisfy either a or b:
\[ \text{a. Two courses in analysis:} \]
MAT 319 or 320 and
MAT 322 or 324 or 341 or 342
\[ \text{b. For students graduating with the} \]
Secondary Teacher Education option: MAT 319 or 320

7. Five mathematics-related courses beyond those taken to satisfy
Requirements 5 and 6 (four will suffice if all of them are MAT courses),
to be chosen from the following:
MAE 301
MAT courses numbered 310 or above except 475
AMS courses numbered 301 or above except 361 and 475
CSE courses numbered 301 or above except 475

A list of acceptable upper-division courses in chemistry, economics, philosophy, and physics is available in the Undergraduate Mathematics Office. Students in the Secondary Teacher Education Program must fulfill a modified version of this requirement, consisting of AMS 310, MAT 336, MAT 360, and MAE courses.

B. Upper-Division Writing Requirement
To satisfy the Departmental writing requirement, each student majoring in Mathematics, including double majors, must submit an acceptable portfolio of three pieces of writing from upper-division MAT or MAE coursework. Students should aim for completion of the portfolio early in their next-to-last semester to allow time to resolve any difficulties. Late completion may delay graduation.

Each portfolio must be submitted no later than the beginning of the final semester, and each piece in it must have been approved by a Departmental faculty member as being mathematically correct and well written.

Notes:
1. Under special circumstances a student may request the director of undergraduate studies to allow substitution of an equivalent individual program for some or all of these requirements.
2. All courses used to fulfill the requirements for the major must be taken for a letter grade and must be completed with a grade of C or higher.
3. Students whose scores on the College Entrance Examination Board (CEEB) Advanced Placement Examination are documented earn credits as follows:
   - 4 or 5 on BC examination: credit for MAT 131, 132 (8 credits);
   - 4 or 5 on AB examination: credit for MAT 131 (4 credits);
   - 3 on either examination: 3 credits applicable to graduation but not the major.
4. Students who learned some linear algebra or multivariate calculus before entering Stony Brook should see an advisor in the Undergraduate Mathematics Office. For a student who has had some linear algebra, it may be appropriate to skip MAT 211 and to enroll directly in MAT 310.
5. Six credits of graduate MAT courses may be used in place of undergraduate courses in Requirement A7.

Honors Program in Mathematics
The honors program is open to junior and senior Mathematics majors who have completed at least two upper-division MAT courses with grades of B or higher and who have maintained a 3.00 overall grade point average. A prospective honors major must declare to the director of undergraduate studies an intention to participate in the program before registering for the senior year.

The program consists of a set of seven MAT courses, at least three of which are not used to fulfill the MAT major requirements. These courses must include: MAT 322 or 324; MAT 401 or 402; a course in algebra other than MAT 310 or 318; and MAT 495. Substitution of appropriate graduate courses is permitted, and other substitutions are possible at the discretion of the undergraduate director. Conferral of honors is contingent upon:

1. Completion of the set of seven courses with a grade point average of at least 3.50;
2. Approval for honors by the faculty member or members who supervise MAT 495.

Mathematics Secondary Teacher Education Program
See the Education and Teacher Certification entry in the alphabetical listings of Approved Majors, Minors, and Programs.

Requirements for the Minor in Mathematics (MAT)
The minor in Mathematics is available for those students who want their formal university records to emphasize a serious amount of upper-division work in mathematics. Although a one-variable calculus sequence is not a requirement, it is a prerequisite for some of the courses listed below. The requirements listed below do not include single variable calculus or MAT 200 Logic, Language, and Proof; these are prerequisites for some of the courses listed below.

1. MAT 211 or AMS 210
2. MAT 203 or AMS 261 or MAT 205
3. MAT 310 or 312 or 313 or 318
4. MAT 319 or 320 or 341 or 342
5. Three additional MAT courses numbered 300 or higher (excluding 475)
Beginning Mathematics Courses
The Mathematics curriculum begins with a choice of calculus sequences, some including preparatory material from 12th-year mathematics in high school and some not. The three first-term calculus courses that assume knowledge of 12th-year mathematics are MAT 125, MAT 131, MAT 141 and AMS 151. A student may start any of these with the same background.

The three-semester sequence of one-variable calculus, MAT 125, 126, 127, is academically equivalent to the two-semester sequence MAT 131, 132. Engineering students normally take the faster-paced MAT 131, 132, or AMS 151, 161 rather than MAT 125, 126, 127 because of the many requirements they must meet. MAT 141, 142 is an enriched version of MAT 131, 132. MAT 171 is a version of MAT 142 for students who did not take MAT 141; offered only in the fall semester.

MAT 122 and MAT 123 combine precalculus and calculus for students who have not had a precalculus course in high school. A student who completes MAT 122 will have learned some precalculus material and will have a good idea of what calculus is and how it is used. MAT 123 is designed to lead into MAT 125 or MAT 131. Although MAT 122 is not designed as preparation for further calculus courses, students may follow that course with MAT 125 or MAT 131 if they take the one-credit course MAT 190 in the same semester as MAT 125 or 131.

MAT 118 is a non-calculus course that surveys various topics in mathematics that do not require a background in precalculus or calculus; it is designed for students who do not intend to take further courses in mathematics.

For students whose high school preparation is insufficient to begin the MAT curriculum, or to enroll in another course applicable to the D.E.C. category C requirement, Mathematical and Statistical Reasoning, there are two review courses numbered MAP 101 and 103. These courses do not carry graduation credit. MAP 103, a skills course, is for students who need further work in high school algebra and related topics before continuing with calculus or other mathematics. Some students, upon completing MAP 103, are able to pass the Mathematics Placement Examination at a level that allows them to go directly into MAT 125 or 131.

Placement
The Department of Mathematics offers a placement examination which indicates the level of mathematical preparation of each student. The score on the examination is used to place the student in appropriate courses in mathematics, applied mathematics and statistics, biology, chemistry, and physics. It tests the student’s skills at the time the test is taken; students are advised to study beforehand. There is a preliminary version of the examination given prior to orientation; all incoming students, including transfers, should take the preliminary placement examination. This exam is used only for registration purposes and cannot be used to fulfill graduation requirements. The preliminary score becomes invalid after two semesters.

A student wishing to use the placement examination to fulfill D.E.C. Category C or other graduation-related requirements or Skill 1, or if they have been or wish to be accepted into a major in the College of Engineering and Applied Sciences, must take a proctored version of the examination. This examination is given several times during the academic year, and by appointment with the Mathematics Department.

The placement exam consists of several parts; not all students will take all parts of the exam. Part I covers high school algebra, Part II deals with 12th year high school mathematics (precalculus), and Part III covers single-variable calculus. The outcome of the test is one of nine levels:

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>MAP 101</td>
</tr>
<tr>
<td>Level 2</td>
<td>MAP 103</td>
</tr>
<tr>
<td>Level 2+ and Skill 1</td>
<td>MAT 118 or statistics</td>
</tr>
<tr>
<td>Level 3</td>
<td>MAT 118, 122, 123 or statistics</td>
</tr>
<tr>
<td>Level 4</td>
<td>MAT 125</td>
</tr>
<tr>
<td>Level 5</td>
<td>MAT 131 or 141 or AMS 151</td>
</tr>
<tr>
<td>Level 6</td>
<td>MAT 126</td>
</tr>
<tr>
<td>Level 7</td>
<td>MAT 132 or 142 or 171 or AMS 161</td>
</tr>
<tr>
<td>Level 8</td>
<td>MAT 127 or 132 or 171 or 142 or AMS 161</td>
</tr>
<tr>
<td>Level 9</td>
<td>Beyond 100-level calculus</td>
</tr>
</tbody>
</table>

Levels 1-3 can be achieved by a sufficiently high score on Part I, and levels 4-5 can be achieved by a sufficiently high score on Part II, and attaining levels 6-9 requires sufficiently high scores on Parts II and III. The entry skill in mathematics requirement may be satisfied by attaining a score of level 3 or higher on the proctored exam. The general education requirement for Mathematics (D.E.C. category C) may be satisfied by attaining a score of level 6 or higher on the proctored exam. Certain majors will also accept a sufficiently high score on the proctored exam in lieu of required math courses. A student who achieves a particular level is free to begin with a mathematics course corresponding to a lower level, so long as taking the course does not mean that credit is given for the same material twice.

Transfer Credit
When they enter, transfer students automatically receive credit toward graduation at Stony Brook for any courses they have already successfully completed at accredited institutions of higher education and that count toward graduation at that institution. The number of credits transferred appears on the Stony Brook transcript with no courses or grades indicated, and the number of transferred credits is unaffected by the student’s score on the Mathematics Placement Examination. In some cases, a course designator ending in PQ (such as MAT 131PQ) may be placed on the student’s transcript. In addition, transferred mathematics courses are automatically evaluated for applicability to the entry skill in mathematics requirement and the D.E.C. category C requirement; this evaluation does not depend on the result of the placement examination.