

Department of  
**Mathematics and Statistics**  
 College of Science

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**Degrees offered:** Bachelor of Science (BS), Bachelor of Arts (BA), and Master of Science (MS) in Mathematics; BS and BA in Mathematics Education; BS in Composite Mathematics-Statistics Education; Master of Mathematics (MMath); BS, BA, and MS in Statistics; MS in Industrial Mathematics; Doctor of Philosophy (PhD) in Mathematical Sciences

**Graduate specializations:** *PhD in Mathematical Sciences*—College Teaching, Interdisciplinary Studies, Pure and Applied Mathematics, and Statistics

## Undergraduate Programs

### Objectives

The Department of Mathematics and Statistics offers a variety of programs and courses designed to prepare students for careers in teaching and for positions as mathematicians and statisticians in industry and government. The department also provides service courses for students in many other disciplines and contributes to the University Studies program by providing Quantitative Literacy and Quantitative Intensive classes.

### Placement of New Students

The mathematics ACT score, on-campus placement tests, and Advanced Placement (AP) calculus and statistics scores are used for placement in 1000-level and 2000-level mathematics and statistics courses. New students and students who are registering for a math class at USU for the first time should have a math ACT score of at least 18 to register for Math 1010 (Intermediate Algebra), a score of at least 19 to register for Stat 1040, and a score of at least 23 to register for Math 1030 (Quantitative Reasoning), Math 1050 (College Algebra), and Math 1060 (Trigonometry).

The alternative to this is to take a placement examination in the Testing Services Office, University Inn 115. A student who has already taken a math class at USU may register for the next higher numbered course, providing he or she received a grade of C- or better in the prerequisite course. Equivalent transfer courses must also have a C- or better grade. Entering students with math ACT scores of less than 18 should register for Math 0900 (Elements of Algebra) or take the placement examination to qualify for a higher-level course. The placement exam requires a small fee.

A math ACT score of at least 27 is needed to begin in Math 1100 or 1210.

Entering students with passing scores on AP calculus or statistics exams will be given 8 semester credits in mathematics for passing either one of the calculus exams, and 4 semester credits for passing the statistics exam. Usually at least part of this credit will be for specific USU courses. Students with an AP calculus AB score of 3 will generally be advised to start in Math 1210 (Calculus I). Students with a score of 4 or 5 on the calculus AB exam or a score of 3 or 4 on the calculus BC exam will be given credit for Math 1210, and will be advised to begin in Math 1220 (Calculus II). Students with a score of 5 on the calculus BC exam will be given credit for Math 1210 and 1220, and advised to begin in Math 2210 (Multivariable Calculus). Students with a score of 3 or higher on the AP statistics exam will be given credit for Stat 2000. Students may also take a placement test in the USU Testing Center to determine if Math 1100 (Calculus Techniques) or Math 1210 (Calculus I) is an appropriate place to start.

The calculus courses Math 1210, 1220, and 2210 are designed for students in mathematics, the sciences, and engineering. Math 1100 (Calculus Techniques) is designed primarily for students in business and a few other majors. All students in calculus classes need strong backgrounds in the material covered in Math 1010 and Math 1050. In addition, the Math 1210, 1220, 2210 sequence requires trigonometry (Math 1060) and a graphics calculator.

Students with outstanding mathematics records in high school and transfer students with some experience in calculus may wish to consult with a departmental advisor prior to registration.

### Departmental Admission Requirements

1. New freshmen admitted to USU in good standing qualify for admission to the major.
2. Transfer students from other institutions need a 2.2 transfer GPA, and students transferring from other USU majors need a 2.0 total GPA for admission to this major in good standing.
3. Students may be admitted to the Mathematics Education major by satisfying either of the above conditions. However, in order to be admitted to the Secondary Teacher Education Program (STEP), and to graduate from the Mathematics Education major (and minor), students must have a cumulative GPA of at least 3.0 in the equivalent of Math 1210, 1220, and 2210, and an overall GPA of at least 2.75.

### University Requirements

All students in the Department of Mathematics and Statistics must satisfy the requirements of USU's University Studies program, described on pages 56-63 of this catalog.

### College of Science Requirements

Every bachelor's degree candidate in the College of Science must complete the following coursework or its equivalent:

1. One year of calculus: Math 1210 and 1220. In some degrees or emphases within degrees, the second semester of calculus may be replaced by Stat 3000. The substitution will be for specific degree programs, not by student choice.
2. One of the following year-long sequences: Biol 1210, 1220; Chem 1210, 1220; Geol 1150, 3200; Phyx 2110, 2120; Phyx 2210, 2220. The chosen sequence must be *outside the student's major department*.

### Bachelor of Arts (BA) Degree

For this degree, students must complete the major requirements for the corresponding BS degree, plus the equivalent of two years of training in a foreign language. The Languages and Philosophy Department is responsible for approving the foreign language coursework for this degree.

### Major Requirements

Major and minor requirements in the Department of Mathematics and Statistics vary from time to time. Students may obtain from the department information about the exact requirements in effect at any given time. Major and minor requirements in effect at the beginning of Fall Semester 2002 are given below.

**Mathematics Major.** Math 1210, 1220, 2210, 2270, 2280, 4200, 4310, 5210, and 5710; any two courses (6 credits) from Math 5110, 5220, 5270, 5310, and 5510; any three additional courses (9 credits) in mathematics at the 5000-level, excluding Actuarial Mathematics (Math 5570, 5580). Note: Math 2250 may substitute for both Math 2270 and 2280; however, Math 2270 and 2280 are recommended.

**Mathematics Education Major.** Stat 1040; Math 1210, 1220, 2210, 2250, 3110, 4200, 4310, 4400, 4620, 5500, and 5710; *Secondary Teacher Education Program (STEP)*: Level 1—ScEd 3100, 3210, Math 3300, 4500; Level 2—ScEd 4200, 4210, SpEd 4000, Math 4300; Level 3—ScEd 5300, 5500, 5600, InsT 5200. Admission to the STEP requires a GPA of at least 3.00 in the equivalent of Math 1210, 1220, and 2210, and an overall GPA of at least 2.75. Graduation from this major also requires an overall GPA of at least 2.75. No more than three repeats in *all* required courses may be used in GPA computations. The STEP is normally completed during the last three semesters of the degree program, and consequently nearly all the mathematics classes in the Mathematics Education Major must be completed before beginning the STEP.

**Composite Mathematics-Statistics Education Major.** Math 1210, 1220, 2210, 2250 or 2270, 3110, 4200, 4310, 4400, 4620, 5500, 5710, Stat 1040, 2000 or 3000, 4920, 5100, 5200, 5890; *Secondary Teacher Education Program (STEP)*: Level 1—ScEd 3100, 3210, Math 3300, 4500, Stat 4500; Level 2—SpEd 4000, ScEd 4200, 4210, Math 4300; Level 3—InsT 5200, ScEd 5300, 5500, 5600. Admission to the STEP requires a cumulative GPA of at least 3.00 in the equivalent of Math 1210, 1220, 2210 and a cumulative GPA of at least 3.00 in Stat 1040, 2000 or 3000, and an overall GPA of at least 2.75. No more than three repeats in all required courses may be used in GPA computations. The STEP is mostly completed in the last three semesters of the degree program.

**Statistics Major.** Math 1210, 1220, 2210, 2270, 4200, 5710 and 5720; CS 1700; Stat 2000 or 3000; Stat 4920, 5100, 5200, 5890; any three additional statistics classes (9 credits) at the 5000-level. One of the three additional classes may be selected from Math 4630, 5570, 5610, and 5760. Note: Math 2250 may substitute for Math 2270.

### Emphasis Requirements

**Computational Mathematics Emphasis.** This emphasis, available in the Mathematics Major, requires the following: Math 1210, 1220, 2210, 2270, 2280, 3310, 4200, 5210, 5610, 5620, and 5710; two courses (6 credits) in mathematics at the 4000-level or above, not including Actuarial Mathematics (Math 5570, 5580); CS 1700, 1710, 1720, 2200, and 2370; any two computer science courses numbered above 4000. Note: Math 2250 may substitute for Math 2270 and 2280. Math 4620 *may not* be counted towards the elective mathematics credit requirement. Students who complete the computer science coursework with a GPA of at least 2.5 automatically earn a minor in computer science.

**Actuarial Science Emphasis.** This emphasis, available in either the Mathematics Major or the Statistics Major, requires the following: Math 1210, 1220, 2210, 2270, 2280, 4200, 4310, 5210, 5570, 5580, 5710, 5720; Stat 2000 or 3000; Stat 4920, 5100; CS 1700; Acct 2010; Econ 2010; BA 3400; one business administration course (3 credits) numbered above 4000. Note: Math 2250 may substitute for Math 2270 and 2280. Admission to this emphasis requires explicit departmental approval.

### Dual Major Requirements

Students who are interested in two or more major areas (in different departments) should consult with a departmental advisor to discuss the possibility of an individually designed degree program. Such programs typically entail completing major requirements in two or more departments, but cooperating departments may agree to waive some requirements in each department to facilitate a dual or triple major.

By meeting requirements for any two separate majors, USU students may earn a **dual major**, meaning *one bachelor's degree* in the *combination* of two approved majors. Students majoring in Mathematics may benefit from combining their major with a Computer Science, Electrical Engineering, Physics, or Statistics major. Following are the requirements for each of these dual majors.

**Mathematics-Computer Science.** Math 1210, 1220, 2250 (or 2270 and 2280), 3310, 4200, 5210, 5610, 5620, 5710; CS 1700, 1710, 1720, 2200, 2370, 2550, 2560, 3000, 3100, 4700, 5000 or 5050; Spch 1050; one of Phil 2400, 2500, 3520, or 4540; 13 credits from the following list: CS 5000, 5050, 5100, 5200, 5300, 5370, 5400, 5450, 5600, 5650, 5700, 5800, 5850, 5890, 5950 (note that CS 5000 and 5050 may not be double counted); Spch 1050; one of the following sequences: Phyx 2210, 2220 or Biol 1210, 1220, or Chem 1210, 1220, 1230, 1240 or Geol 1150, 3200, plus one additional computer science advisor-approved science course so that the total in this sequence section is at least 13 credits; plus one additional University Studies class (3 credits) from the BAI, BHU, BSS, or BCA approved lists.

**Mathematics-Electrical Engineering Major.** All courses in the Electrical Engineering major; Math 1210, 1220, 2210, 2250, 4200, 4310, 5210, 5710; and three additional courses (9 credits) in mathematics numbered above 4600, excluding Math 5570 and 5580. Note: Only one of Math 4620 and 4630 may count towards the elective credit in mathematics.

**Mathematics-Physics Major.** Math 1210, 1220, 2210, 2270, 2280, 4200, 4310, 5210, 5710; Phyx 2210, 2220, 2710, 3550, 3600, 3650 or 3700, 3870, and 4900; two additional courses in mathematics numbered above 4600; 8 additional credits in physics numbered above 3500, excluding University Studies Depth courses. Note: Math 2250 may substitute for Math 2270 and 2280. Math 4620 *may not* count towards the elective credit in mathematics. Phyx 2110 and 2120 may substitute for Phyx 2210 and 2220.

**Mathematics-Statistics Major.** Math 1210, 1220, 2210, 2270, 2280, 4200, 4310, 5210, 5710, and 5720; Stat 2000 or 3000; Stat 4920, 5100, 5200, 5890; CS 1700; at least two mathematics courses (6 credits) numbered above 5000; at least two statistics courses (6 credits) numbered above 5000. Note: Math 2250 may substitute for Math 2270 and 2280. Either Math 5570 or 5760 may substitute for one of the statistics elective courses.

### Minor Requirements

**Mathematics Minor.** Math 1210, 1220, 2210, 2270, 2280; two courses (6 credits) in mathematics numbered above 4000, excluding Math 4300, 4400, 4500, and 4620. Note: Math 2250 may substitute for Math 2270 and 2280.

**Statistics Minor.** Stat 2000 or 3000; Stat 5100, 5200; two courses (6 credits) from statistics courses numbered above 5000 or from Math 5710, 5720, and 5760.

**Mathematics Education Minor.** Stat 1040; Math 1210, 1220, 2210, 2270, 3110, 4200, 4310, 4400, 4500, 4620, 5500; Secondary Teacher Education Program (STEP) for the student's Secondary Education major. Note: Math 2250 may substitute for Math 2270. Admission to the STEP requires a GPA of at least 3.00 in the equivalent of Math 1210, 1220 and 2210, and an overall GPA of at least 2.75. Graduation from this minor also requires an overall GPA of at least 2.75. No more than three repeats in *all* required courses may be used in GPA computations. The STEP is normally completed during the last three semesters of study, and consequently nearly all the mathematics classes in the Mathematics Education Minor must be completed before beginning the STEP.

**Biomathematics Minor.** Biol 1210, 1220; Math 1210, 1220, 2270, 2280; Stat 3000; Math/Biol 4230. (Note: Math 2250 may substitute for Math 2270 and 2280.) Biology majors must take one course from the biology electives (listed below), and two courses from the mathematics and statistics electives (listed below). Mathematics and Statistics majors must take two courses from the biology electives, and one course from the mathematics and statistics electives. All other majors must take two courses from each set of electives. *Biology Electives:* Biol 5170, 5200, 5600, 5620; PubH 5330; FRWS 3400; Bmet 5500. *Mathematics and Statistics Electives:* Math 4630, 5410, 5420, 5460, 5610, 5620, 5710; Stat 5100, 5110, 5120, 5200, 5300, 5600.

### Additional Information

Students who enter the University with AP credit in Mathematics and/or Statistics, and about 30 additional AP or CLEP credits, may be able to complete both a BS and an MS degree within five years or less. Interested students should consult with a departmental undergraduate advisor.

## Financial Support

The department offers several one-, two-, and four-year scholarships to qualified students who enroll as full-time Mathematics, Mathematics Education, or Statistics majors. The winner of the Hunsaker Scholarship receives a cash award each semester for two years. This award is given in addition to any four-year scholarship or tuition waiver for which the student is eligible. During the final two years, the recipient is expected to work as a grader or tutor for the department. The department also offers other scholarships (Elich, Ellis, and departmental). The amount of these scholarships varies from year to year. The Ellis Scholarship is awarded to a junior or senior Mathematics Education major, and the recipient is selected by the department. In the coming years, a new scholarship from the Arthur van Vliet endowment will be awarded. To apply for any of these scholarships (except for the Ellis Scholarship, for which there is no application) send a statement of qualifications, including high school transcripts and SAT or ACT scores, and three letters of recommendation to:

Scholarship Committee  
Department of Mathematics and Statistics  
Utah State University  
3900 Old Main Hill  
Logan UT 84322-3900

Applications must be received by April 1.

## Graduate Programs

### Admission Requirements

See the general admission requirements for graduate programs at Utah State University on pages 72-73 of this catalog. In general, students wishing to pursue graduate studies in mathematics or statistics should have a bachelor's degree in mathematics, statistics, or a closely related field, with extensive coursework in one of the departmental disciplines.

Students entering the Master of Mathematics (MMath) program must either possess a valid secondary school teaching license or be concurrently enrolled in a secondary school teacher licensure program.

### Degree Programs

**Master of Science (MS).** The department offers MS programs in mathematics and statistics. This degree is a terminal degree for most students, but is also a "stepping stone" for students who ultimately wish to pursue a doctorate in mathematics or statistics.

**Master of Mathematics (MMath).** This program is designed specifically for secondary school teachers of mathematics. The purpose of this degree is to provide students with a broad background in mathematics.

**Master of Science (MS) in Industrial Mathematics.** The Industrial Mathematics master's degree is designed to broaden the learning experiences and job opportunities for master's students in mathematics. The program of study incorporates fundamental applied mathematics and interdisciplinary coursework in support of an industrial internship experience.

**Doctor of Philosophy (PhD) in Mathematical Sciences.** This is a terminal degree for mathematics and statistics researchers in academe, government, and industry, as well as for prospective college teachers.

## Specializations for PhD in Mathematical Sciences

The **College Teaching Specialization** is designed to prepare students to teach undergraduate mathematics in two- and four-year colleges and in universities. This program is less specialized than the other two options. Students in the College Teaching specialization receive broad training in pure and applied mathematics. The dissertation for this specialization includes exposition of important mathematical theories and their historical relationships in an area of mathematics of the student's choosing.

The **Interdisciplinary Studies Specialization** offers advanced training in mathematics as a research tool. The mathematical component emphasizes areas of applied mathematics. In addition, the student receives graduate-level training in the chosen area of application. The student's course of study and research is directed both by scholars in mathematics and by scholars in the related discipline. The dissertation involves the development and application of mathematics in the context of research problems arising in the chosen interdisciplinary area.

The **Pure and Applied Mathematics Specialization** is a traditional doctoral program in mathematics, offering broad training in the foundations of modern mathematics together with specialized training in an area of mathematical research. The dissertation represents a significant contribution to mathematics research in the chosen area of specialization.

The **Statistics Specialization** offers broad training in theoretical and applied statistics for students seeking careers in academia, industry, or government. The dissertation represents a significant contribution to statistical research.

### Course Requirements

Departmental requirements change from time to time. Check with the Department of Mathematics and Statistics for the list of requirements currently in effect. The requirements listed below are in effect for Fall Semester 2002.

**Master of Science in Mathematics.** This degree requires 30 credits of approved coursework at or above the 5000 level. At least 18 of these credits must be at the 6000 level or above, excluding Math 6990 and 7990 (Continuing Graduate Advisement) and Math 7910 (College Teaching Internship). Generally, most of the coursework will be in mathematics, but the student's supervisory committee may approve courses in statistics, physics, engineering, or any other discipline, if it seems such coursework is appropriate for the student's program of study.

The MS in mathematics has three options. The Plan A or the thesis option requires taking 6 credits of Math 6970 (Thesis and Research) and working with a faculty member on a substantial research project. The research must be presented in a thesis, which must be approved by the student's supervisory committee and the dean of the School of Graduate Studies. An oral defense of the thesis must be arranged through the School of Graduate Studies.

The Plan B or project option requires taking 3 credits of Math 6970 and working with a faculty member on a smaller research project. A written report of the research must be approved by the student's supervisory committee. An oral defense of the report must be scheduled through the School of Graduate Studies.

The third option of the MS in Mathematics requires only coursework, and is called the Plan C option.

All students in the MS program in Mathematics must pass a written qualifying examination covering the introductory analysis and advanced calculus material presented in Math 4200, 5210, and 5220. Students may take this exam before beginning formal coursework in the MS program, and must take the exam at the end of the first full year of matriculation. The exam is typically given twice a year, in May and September. Matriculated students who fail on their first try must pass the exam at the next scheduled opportunity. A detailed exam syllabus is contained in the *Graduate Handbook*, available from the department.

**Master of Science in Statistics.** This degree requires 30 credits of approved coursework at or above the 5000 level. At least 18 credits must be at the 6000 level or above, excluding Stat 6990 and Stat 7990 (Continuing Graduate Advisement). All students must take Stat 6710 and 6720 (Mathematical Statistics I and II). Generally, most of the coursework will be in statistics, but the student's supervisory committee may approve courses in mathematics, biology, economics, or any other discipline if it deems such coursework to be appropriate for the student's program of study.

The MS in statistics has Plan A (thesis), Plan B (report), and Plan C (coursework only) options. The Plan A and Plan B options require students to work with a faculty member on a research project, taking 6 or 3 credits of Math 6970, respectively, and presenting the results of the research in a written report. For both the Plan A and Plan B options, the report must be approved by the student's supervisory committee. A Plan A report (thesis) must also be approved by the dean of the School of Graduate Studies. Both Plan A and Plan B reports require an oral defense that must be scheduled through the School of Graduate Studies.

Students in all three options of the MS in Statistics must pass a written qualifying examination based on the material presented in Stat 3000 (Statistics for Scientists), Math 5710 (Introduction to Probability), and Math 5720 (Introduction to Mathematical Statistics). Students may take the exam before beginning any formal coursework in the MS program. Students must attempt the exam by the end of the first full year of matriculation. The exam is usually given in late May and early August each year. Matriculated students who fail the exam on their first try must pass the exam at the next scheduled opportunity. A detailed exam syllabus is available in the *Graduate Handbook*, available from the department.

**Master of Mathematics.** This program requires at least 36 credits approved by the Graduate Committee within the Department of Mathematics and Statistics. At least 21 of these credits must come from mathematics classes numbered above 5000. Math 4620 or an approved substitute must also be included. The GPA for the 36 credits and for the 21 math credits must be at least 3.0.

**Master of Science in Industrial Mathematics.** This degree requires 36 credits of coursework at or above the 5000 level. At least 15 of these credits must be completed in Math courses at the 6000 level or above. Additionally, students must complete a total of 9 credits outside of Mathematics which complement their internship and final project. A maximum of 3 of these credits may be taken at the 5000-level (i.e., one 3-credit course in another department). See the departmental website or the *Graduate Handbook* for more detailed information about coursework requirements.

Students are required to pass the Advanced Calculus examination (see the Master of Science in Mathematics examination re-

quirements), *or* the Statistics qualifying examination (see the Master of Science in Statistics examination requirements), *or* an examination based on material presented in four core courses chosen by the student during the first year. The exam, which can be taken before or at the beginning of the student's second year in the program, is usually given in late May or early August. Students are also required to complete a final project based on work done during an internship, either with a company or possibly with another department on campus. The project will include a technical write-up suitable to the industry/field, and presentation to the involved faculty and students in the program. This follows the Plan B option listed for the Master of Science in Mathematics degree.

The Departmental Graduate Committee supervises all MS and MMath students until a supervisory committee for the student is established and approved. Prior to advancement to candidacy, students in Plan A and Plan B options for the MS degree in mathematics and statistics must pass an examination in English writing. This exam is administered by the Department of Mathematics and Statistics.

**PhD in Mathematical Sciences.** In all the doctoral specializations, a course of study consists of 90 credits beyond a bachelor's degree or 60 credits beyond a master's degree. The minimal course requirements described below assume that the student needs 90 credits. In all specializations, credit may be earned toward a master's degree, as part of the 42 required credits (see below), but coursework cannot be applied to two degrees. The complete course of study must be approved by the student's supervisory committee.

**College Teaching Specialization.** Seven course sequences (42 credits) in mathematics courses numbered 6000 and above, excluding Math 7970 and including at least 6 credits in seminars and topics courses in mathematics at the 7000 level and 6 credits of Math 7910 (College Teaching Internship), are required.

**Interdisciplinary Studies Specialization.** Forty-two (42) credits in courses numbered 6000 and above, excluding Math 7970 and including at least four course sequences (24 credits) in mathematics, 6 credits in seminars and topics courses in mathematics at the 7000 level, and approved courses in the student's interdisciplinary area, are required.

**Pure and Applied Mathematics Specialization.** Seven course sequences (42 credits) in mathematics courses numbered 6000 and above, excluding Math 7970 and including at least 6 credits in seminars and topics courses at the 7000 level, are required.

**Statistics Specialization.** Seven course sequences (42 credits) in mathematics or statistics in courses numbered 6000 and above, excluding Math 7970 and Stat 7970 and including at least 6 credits in seminars and topics courses at the 7000 level, are required.

### ***Common Degree Requirements***

For all students in the Pure and Applied Mathematics, the Interdisciplinary Studies, and the Statistics specializations, a maximum of 30 credits of Math 7970 (Dissertation Research) is allowed. Students in the College Teaching Specialization are allowed a maximum of 20 credits of Math 7970.

Besides the coursework described, the general requirements for the PhD include:

1. Competency in advanced calculus.
2. Passing three written comprehensive examinations. The exams are given in May and September. Some latitude in subject is permitted, although all students in mathematics must pass an examination in real analysis. All comprehensive exams in mathematics and statistics must be passed within a single 13-month period. This period begins with the first sitting for such an examination, but may not begin later than the September following the first full academic year as a matriculated PhD student. Students are encouraged to sit for all three exams within a 7-day period, but sitting for fewer is permitted. A student need not repeat exams already passed. For the Statistics Option, all students must pass three written exams, two of which must be examinations in probability, linear models, or mathematical statistics. Detailed syllabi for all exams may be obtained from the Department of Mathematics and Statistics. Old exams are also available.
3. Completion of an examination in English writing.
4. Completion of a dissertation.
5. Passing a final oral examination defending the dissertation and demonstrating a general knowledge of mathematics.

## Research

Mathematics research opportunities within the department are many and varied, and students are urged to contact faculty about mutual interests at as early a stage as feasible. The interdisciplinary option permits and encourages study with a broad spectrum of outstanding nationally recognized University research programs.

## Financial Assistance

The department offers full-time teaching assistantships, half-time paper-grading assistantships, research fellowships, and work-study assistance for students in all graduate degree programs. Stipends vary from \$6,500 for a half-time paper-grading assistantship to \$13,000 for teaching assistants pursuing a master's degree. Stipends for PhD students range from \$14,000 for incoming students to \$16,000 for students who have passed all three comprehensive examinations. Normally, a teaching assistant has responsibility for a single course each semester. Out-of-state tuition waivers are usually given with each full-time teaching or half-time paper-grading assistantship. All tuition is usually waived for PhD students. Applications for teaching assistantships should be mailed by March 1 of each year.

## Mathematics Courses (Math)

**Math 0900. Elements of Algebra.** Review of elementary algebra in preparation for Math 1010. Remedial class not carrying USU or transfer credit. Remedial fee required. (3 cr) (F,Sp,Su) ©

**Math 1010. Intermediate Algebra.** Linear equations and inequalities, polynomials and exponents, rational expressions, roots and radicals, quadratic equations, lines and systems of linear equations. Prerequisite: Math 0900 or Math ACT score of at least 18, or successful completion of placement test. Required for entrance to USU. Course fee required. (3 cr) (F,Sp,Su) ©

**Math 1030 (QL). Quantitative Reasoning.** Exploration of contemporary mathematical thinking, motivated by its application to problems in modern society. Emphasizes development of skill in analytical reasoning. Prerequisite: Math ACT score of at least 23, satisfactory score on placement exam for Math 1050, or Math 1010. (3 cr) (F,Sp,Su)

**Math 1050 (QL). College Algebra.** Real and complex number systems, graphs, inverse functions, polynomial and rational functions, exponential and logarithmic functions, systems of equations, elementary matrix algebra, induction, binomial theorem, permutations and combinations. Graphing calculator required. Prerequisite: Math 1010, or Math ACT score of at least 23, or satisfactory score on placement exam. (4 cr) (F,Sp,Su) ©

**Math 1060. Trigonometry.** Trigonometric functions, equations, identities, and applications. Graphing calculator required. Prerequisite: Math 1010, or Math ACT score of at least 23, or satisfactory score on placement exam. May be taken concurrently with Math 1050. (2 cr) (F,Sp,Su) ©

**Math 1100 (QL). Calculus Techniques.** Techniques of elementary calculus, differentiation, integration, elementary optimization, and introduction to partial derivatives. Applications in business, social science, and natural resources. Graphing calculator required. Prerequisite: Math 1050, or a math ACT score of at least 25. (3 cr) (F,Sp,Su)

**Math 1210 (QL). Calculus I.** Analytic geometry, differential and integral calculus, transcendental functions, and applications. Graphing calculator required. Prerequisites: Math 1050 and 1060, or an AP calculus score of at least 3 on the AB test, or a math ACT score of at least 27. (4 cr) (F,Sp,Su)

**Math 1220 (QL). Calculus II.** Integration, infinite series, introduction to vectors, and applications. Graphing calculator required. Prerequisite: Math 1210, or AP score of at least 4 on calculus AB exam or at least 3 on calculus BC exam. (4 cr) (F,Sp,Su)

**Math 2020 (QI). Introduction to Logic and Geometry.** Logic; introduction to algebraic geometry and Euclidean geometry. Math 2020 is a mathematics content course, not a methods course. Prerequisite: Math 1050 or math ACT score of at least 25. Course fee required. (3 cr) (F,Sp)

**Math 2210 (QI). Multivariable Calculus.** Vector calculus, multiple integration, partial derivatives, line and surface integrals. The theorems of Green, Gauss, and Stokes. Prerequisite: Math 1220 or AP calculus score of 5 on BC exam. (3 cr) (F,Sp,Su)

**Math 2250 (QI). Linear Algebra and Differential Equations.** Linear systems, abstract vector spaces, matrices through eigenvalues and eigenvectors, solution of ode's, Laplace transforms, first order systems. Prerequisite: Math 1220 or AP calculus score of 5 on BC exam. (4 cr) (F,Sp,Su)

**Math 2260. Internship and Cooperative Studies.** Lower-division internship/cooperative work experience. (1-6 cr) (F,Sp,Su) ®

**Math 2270 (QI). Linear Algebra.** Topics from linear algebra, including matrices, abstract vector spaces, linear independence, bases, eigenvalues, eigenvectors, orthogonality, least squares approximation, and linear transformations. Recommended for Math and Math Education majors. Prerequisite: Math 1220 or AP math score of 5 on calculus BC exam. (3 cr) (F)

**Math 2280 (QI). Ordinary Differential Equations.** First-order differential equations: solution techniques, numerical methods and applications. Higher-order scalar equations; linear systems, phase plane analysis. Additional topics selected from: series solution techniques, boundary value problems, Sturm-Liouville theory, bifurcation analysis. Prerequisites: Math 2210 and 2270. (3 cr) (Sp)

**Math 2910. Directed Reading and Conference.** Prerequisite: Prior arrangement with specific instructor. (1-3 cr) (F,Sp,Su) ®

**Math 3110. Modern Geometry.** Euclidean and non-Euclidean geometry, with emphasis on historical significance of parallel postulate. Axiomatic development of geometry and theorems. Prerequisite: Math 1220. (3 cr) (Sp)

**Math 3300. School Laboratory for Mathematics Teachers Level I.** Provides preservice mathematics teachers with supervised experiences working with teachers and students in middle and secondary schools. Activities coordinated with other Level I professional education courses, including Math 4500 and ScEd 3100. Concurrent enrollment required in InsT 5200, ScEd 3210, and a special methods course. (1 cr) (F,Sp)

**Math 3310. Discrete Mathematics.** Logic and axiomatics, sets, functions, counting methods, recurrence relations, graph theory, Boolean algebras, combinatorial circuits, automata, grammars, and languages. Prerequisite: Math 1220. (3 cr) (F,Sp,Su)

**Math 4200 (CI). Foundations of Analysis.** Fundamental concepts of analysis studied from a rigorous point of view. Rigorous development of the real number system and calculus. Emphasis on learning how to construct proofs. Prerequisites: Math 2210, 2250; or Math 2210, 2270, 2280. (3 cr) (F,Sp)

**\*\*Math 4230 (QI). Applied Mathematics in Biology.** Formulation, analysis, and experimental tests of mathematical models in biology. Combines mathematics, computing, experimental design, and statistical analysis while applying the scientific method to biological systems. Lectures, recitations, and a laboratory. Prerequisites: Biol 1220 and Math 2250; or permission of instructor. Programming experience recommended. Also taught as Biol 4230. (3 cr) (Sp)

**Math 4250. Advanced Internship/Co-op.** An internship/cooperative work experience which has been determined by the department to be at the 4000-level. (1-6 cr) (F,Sp,Su) ®

**Math 4300. School Laboratory for Mathematics Teachers Level II.** Provides preservice mathematics teachers with supervised experiences working with teachers and students in middle and secondary schools. Activities coordinated with other Level II professional education courses, including Math 4500 and ScEd 4100. Concurrent enrollment required in SpEd 4000, ScEd 4200, 4210, and a special methods course. (1 cr) (F,Sp)

**Math 4310 (CI). Introduction to Algebraic Structures.** First course in theory of algebraic structures. Topics include elementary group and ring theory. Prerequisites: Math 2210, 2270, 2280; or Math 2210, 2250. (3 cr) (F,Sp)

**Math 4400. History of Mathematics and Number Theory.** Chronological parallel of math history with civilization, evolution of mathematical thought, historical foundations of numbers, computation, geometry, algebra, trigonometry, and calculus. Introduction to number theory. Prerequisites: At least one of Math 4200 and 4310, and concurrent enrollment in the other. (3 cr) (Sp)

**Math 4500. Methods of Secondary School Mathematics Teaching.** A teaching methods course required of all prospective secondary school mathematics teachers. Prerequisites: Math 3110; and one of Math 4200 or 4310. (3 cr) (F,Sp)

**Math 4620. Computer Aided Math for Secondary Math Teachers.** Problem solving using symbolic manipulation software on computers. Topics include material introduced in Math 1210, 1220, 2210, 2250, 2270, and 2280. Includes instruction in the use of modern computerized devices in the classroom. Prerequisites: Math 2210, 2250; or Math 2210, 2270, 2280. (3 cr) (F)

**Math 4630. Computer Aided Math for Scientists and Engineers.** Problem solving for scientists and engineers, using symbolic manipulation software on computers. Undergraduate mathematical concepts are revisited and extended. Prerequisites: Math 2210, 2250; or Math 2210, 2270, 2280. (3 cr) (Sp)

**Math 4910. Directed Reading and Conference.** Registration requires prior arrangement with specific instructor. (1-3 cr) (F,Sp,Su) ®

**\*\*Math 5110. Differential Geometry.** Introduction to geometry of curves and surfaces in three dimensions, using graphic and symbolic software. Prerequisites: Math 2210, 2250; or Math 2210, 2270, 2280. (3 cr) (F)

**Math 5210. Introduction to Analysis I.** One and several variable calculus from an advanced point of view. Proofs of all main theorems in calculus. Prerequisite: Math 4200 or 5510. (3 cr) (F)

**Math 5220. Introduction to Analysis II.** Continuation of Math 5210. Rigorous development of multivariable advanced calculus. Prerequisite: Math 5210. (3 cr) (Sp)

**\*\*Math 5270. Complex Variables.** Basic theory and applications of complex variables for mathematics, physics, and engineering students. Topics include analytic functions, contour integration, and residue theorem conformal mappings. Prerequisites: Math 2210, 2250; or Math 2210, 2270, 2280. (3 cr) (Sp)

**\*\*Math 5310. Introduction to Modern Algebra.** Continuation of Math 4310. Topics include: Sylow theory for finite groups, factorization theory for commutative rings, and Galois theory. Prerequisite: Math 4310. (3 cr) (Sp)

**Math 5340. Theory of Linear Algebra.** Vector space theory, linear transformations and matrices, eigenvalues and eigenvectors, inner product spaces, orthogonality, canonical forms, and Hermitian matrices. Prerequisites: Math 2250 or 2270; or consent of instructor. (3 cr) (Sp)

**Math 5410. Methods of Applied Mathematics.** Basic modeling and qualitative understanding, including dimensional analysis (Buckingham Pi theorem). Asymptotic solutions, perturbation approaches, boundary layers in differential equations, variational calculus, Hamilton's principle, and conservation of energy. Emphasizes practical approaches to science and engineering problems. Prerequisites: Math 2210, 2250; or Math 2210, 2270, 2280. (3 cr) (F)

**Math 5420. Partial Differential Equations.** Modeling with partial differential equations, diffusion, and wave equations. Classical solution techniques including: maximum principles, separation of variables (eigenfunctions), method of characteristics, Fourier and Laplace transforms, and singularity methods (Green's Functions). Emphasizes understanding and solving physical equations. Prerequisite: Math 2250 or 2280. (3 cr) (Sp)

**Math 5460. Introduction to the Theory and Application of Nonlinear Dynamical Systems.** Qualitative behavior of nonlinear maps and ordinary differential equations. Stability of solutions, bifurcation theory, chaos, and applications. Prerequisite: Math 2250 or 2280. (3 cr) (Sp)

**Math 5500. Capstone Mathematics and Statistics for Teachers.** Builds on competencies attained in mathematics and statistics, enabling students to connect with and relate mathematics and statistics to real-world problem solving, while enhancing their capacity to explain conceptual mathematics. Prerequisites: Math 4200, 4310, and 4400. (3 cr) (F)

**Math 5510. Introduction to Topology.** Elementary point-set topology, topological spaces, separation axioms, metric spaces, compactness, connectedness, order topology, countability axioms, continuity, and homeomorphisms. Prerequisite: Math 2210 or equivalent. (3 cr) (F)

**\*\*Math 5570. Actuarial Math I.** Introduction to theory of risk and its application to construction and analysis of models for insurance systems. Prerequisites: Math 5710, Stat 3000, and permission of instructor. (3 cr) (F)

**\*\*Math 5580 (CI). Actuarial Math II.** Continuation of Math 5570. Prerequisite: Math 5570. (3 cr) (Sp)

**Math 5610. Computational Linear Algebra and Solution of Systems of Equations.** Numerical solutions of systems of linear and nonlinear equations, methods for eigensystems, least squares problems, finding roots of functions and nonlinear systems, constrained and unconstrained optimization. Prerequisites: Math 2210, Math 2250 or 2270, and a high-level programming language. (3 cr) (F)

**\*Math 5620. Numerical Solution of Differential Equations.** Numerical solution of differential equations, initial and boundary value problems, finite difference, finite element, and spectral methods (FFT) applied to ODEs and PDEs. Prerequisites: Math 2210; Math 2250 or 2270; Math 2280; and a high-level programming language. (3 cr) (Sp)

**Math 5640. Optimization.** One-semester introductory survey of optimization, including both continuous and combinatorial problems. Topics include: linear programming, constrained and unconstrained optimization, network models, dynamic programming, and integer programming. Prerequisites: Math 2210; and Math 2250 or 2270. (3 cr) (Sp)

**Math 5710. Introduction to Probability.** Discrete and continuous probability, random variables, distribution and density function, joint distributions, conditional probabilities and expectations, Bayes' theorem, moments, moment generating functions, inequalities, convergence in probability and distribution, and central limit theorem. Prerequisites: Math 2210; and Math 2250 or 2270. (3 cr) (F,Sp)

**Math 5720. Introduction to Mathematical Statistics.** Basic theory of point and interval estimation and hypothesis testing. Topics include: sufficiency and completeness; method-of-moments, best unbiased, maximum likelihood, Bayes', and empirical Bayes' estimators; Neyman-Pearson lemma; and likelihood ratio tests. Prerequisite: Math 5710. (3 cr) (Sp)

**\*Math 5760. Stochastic Processes.** Application of stochastic processes to engineering and science. Topics include Markov chains, Poisson processes, renewal theory, and Brownian motion. Prerequisite: Math 5710. (3 cr) (F)

**Math 5810, Math 5820. Topics in Mathematics.** Prerequisite: Permission of instructor. (1-3 cr) (F,Sp,Su) (1-3 cr) (F,Sp,Su) ®

**Math 5910. Directed Reading and Conference.** Prerequisite: Prior arrangement with a specific instructor. (1-3 cr) (F,Sp,Su) ®

**Math 5950H. Honors Senior Project.** A senior project required for completion of the departmental honors program. Prerequisite: Permission of instructor. (1-4 cr) (F,Sp,Su)

**\*Math 6110, Math 6120. Differential Geometry.** Topics include manifolds, calculus on manifolds, tensor calculus and differential forms, Lie groups, Riemannian geometry, deRham's Theorem, and Hodge theory. Prerequisite: Math 5110 or 5220; Math 6110 must be completed prior to Math 6120. (3 cr) (F) (3 cr) (Sp)

**\*Math 6210, Math 6220. Real Analysis.** Measure theory, abstract integration, differentiation, introduction to functional analysis, Hilbert and Banach spaces. Prerequisite: Math 5210; Math 6210 must be completed prior to 6220. (3 cr) (F) (3 cr) (Sp)

**\*Math 6250. Graduate Internship/Cooperative Studies.** Graduate internship/cooperative work experience. (1-6 cr) (F,Sp,Su) ®

**\*Math 6270. Complex Variables.** Analytic functions, singular points, conformal maps, harmonic functions, analytic continuation, Residue theory. Prerequisite: Math 5210 or 5270. (3 cr) (Sp)

**\*Math 6310, Math 6320. Modern Algebra.** Algebraic structures, including vector spaces, groups, rings, algebras, and modules. Topics include: category theory, elementary commutative ring theory, and algebraic geometry. Prerequisite: Math 5310; Math 6310 must be completed prior to 6320. (3 cr) (F) (3 cr) (Sp)

**\*Math 6340, Math 6350. Multilinear Algebra and Matrix Theory.** Permutation groups and representations, tensor spaces, symmetry classes of tensors, generalized matrix functions, matrices and graphs, and combinatorial matrix algebra. Prerequisite: Math 5340; Math 6340 must be completed prior to 6350. (3 cr) (F) (3 cr) (Sp)

**\*Math 6410. Ordinary Differential Equations I.** Existence-uniqueness theory, linear equations and systems, nonlinear equations, and stability. Prerequisite: Math 5210. (3 cr) (F)

**\*Math 6420. Partial Differential Equations I.** Introduction to the theory of partial differential equations, including existence and uniqueness. Prerequisite: Math 5220 or 6410. (3 cr) (Sp)

**\*Math 6440. Ordinary Differential Equations II.** Asymptotic behavior, periodicity, boundary value problems, and perturbation methods. Prerequisite: Math 6410. (3 cr) (Sp)

**\*Math 6450. Partial Differential Equations II.** Advanced existence and uniqueness theorems, behavior of solutions, Sobolev spaces. Prerequisites: Math 6210; and Math 5420 or 6420. (3 cr) (Sp)

**\*Math 6470. Advanced Asymptotic Methods.** Theory of asymptotics and perturbations. Boundary layers for ordinary and partial differential equations. Free boundary problems, shocks, multiple-scale methods, and WKB methods. Prerequisite: Math 5420. (3 cr) (Sp)

**\*Math 6510, Math 6520. Topology.** Homotopy theory, fundamental groups, covering spaces, singular homology with applications to spheres and Euclidean spaces, CW complexes, cohomology ring, and Poincare duality. Prerequisites: Math 4310, 5510; and Math 5310 or consent of instructor. Math 6510 must be completed prior to 6520. (3 cr) (F) (3 cr) (Sp)

**\*Math 6610. Numerical Analysis.** Linear and nonlinear equations, large scale problems, and eigenvalues. Prerequisites: Math 5210, 5610, or consent of instructor. (3 cr) (F)

**\*Math 6620. Numerical Analysis.** Numerical solution of ordinary and partial differential equations. Prerequisite: Math 6610 or consent of instructor. (3 cr) (Sp)

**\*Math 6640. Optimization.** Unconstrained problems, smooth function methods, linearly constrained problems, linear and quadratic programming, nonlinearly constrained methods, and practicalities. Prerequisite: Math 5220 or consent of instructor. (3 cr) (Sp)

**\*Math 6750, Math 6760. Probability Theory.** Probability spaces, random variables, distribution functions, expectations, independence, modes of convergence, limit theorems, and applications. Prerequisite: Math 5210; Math 6750 must be completed prior to 6760. (3 cr) (F) (3 cr) (Sp)

**\*Math 6810, Math 6820. Topics in Mathematics (Topic).** Prerequisite: Consent of instructor. (3 cr) (F) (3 cr) (Sp) ®

**\*Math 6910. Directed Reading and Conference.** Prerequisite: Prior arrangement with specific instructor. (1-3 cr) (F,Sp,Su) ®

**Math 6970. Thesis.** (1-9 cr) (F,Sp,Su) ®

**Math 6990. Continuing Graduate Advisement.** (1-3 cr) (F,Sp,Su) ®

**\*Math 7110, Math 7120. Geometry (Topic).** (3 cr) (F) (3 cr) (Sp) ®

**\*Math 7210, Math 7220. Analysis (Topic).** (3 cr) (F) (3 cr) (Sp) ®

**\*Math 7310, Math 7320. Algebra (Topic).** (3 cr) (F) (3 cr) (Sp) ®

**\*Math 7410, Math 7420. Differential Equations (Topic).** (3 cr) (F) (3 cr) (Sp) ®

**\*Math 7510, Math 7520. Topology (Topic).** (3 cr) (F) (3 cr) (Sp) ®

**\*Math 7610, Math 7620. Numerical Analysis (Topic).** (3 cr) (F) (3 cr) (Sp) ®

**\*Math 7750, Math 7760. Probability (Topic).** (3 cr) (F) (3 cr) (Sp) ®

**\*Math 7810, Math 7820. Topics in Mathematics (Topic).** (3 cr) (F) (3 cr) (Sp) ®

**Math 7910. College Teaching Internship.** (3 cr) (F,Sp,Su) ®

**Math 7970. Dissertation Research.** (1-15 cr) (F,Sp,Su) ®

**Math 7990. Continuing Graduate Advisement.** (1-9 cr) (F,Sp,Su) ®

## Statistics Courses (Stat)

**Stat 1040 (QL). Introduction to Statistics.** Descriptive and inferential statistical methods. Emphasis on conceptual understanding and statistical thinking. Examples presented from many different areas. Prerequisite: Math ACT score of 19 or greater, Math 1010, or 70 percent or greater on Math 1050 placement test. (3 cr) (F,Sp,Su) ©

**Stat 2000 (QI). Statistical Methods.** Introduction to statistical concepts, graphical techniques, probability, distributions, estimation, one and two sample testing, chi-square tests, and simple linear regression. Prerequisite: Math 1050. (3 cr) (F,Sp,Su) ©

**Stat 2250. Internship and Cooperative Studies.** Lower-division internship/cooperative work experience in statistics. (1-6 cr) (F,Sp,Su)

**Stat 2300 (QL). Business Statistics.** Descriptive and inferential statistics, probability, sampling, estimation, tests of hypotheses, linear regression and correlation, chi-square tests, analysis of variance, and multiple regression. Prerequisite: Math 1050. (4 cr) (F,Sp,Su) ©

**Stat 2950. Directed Reading and Conference.** Prerequisite: Prior arrangement with specific instructor. (1-3 cr) (F,Sp,Su) ®

**Stat 3000 (QI). Statistics for Scientists.** Introduction to statistical concepts, graphical techniques, discrete and continuous distributions, parameter estimation, hypothesis testing, and chi-square tests. Prerequisites: Math 1100 or 1210. (3 cr) (F,Sp)

**Stat 4250. Advanced Internship/Co-op.** Advanced educational work experience in statistics. Prerequisite: Approval of instructor. (1-6 cr) (F,Sp,Su) ®

**Stat 4500. Methods of Teaching Statistics in Secondary and Middle School.** Teaching methods course required for all prospective mathematics and statistics composite teaching majors. (3 cr) (F,Sp)

**Stat 4910. SPSS Shortcourse.** Access to and use of the SPSS statistical software package. (1 cr) (F,Sp,Su)

**Stat 4920. SAS Shortcourse.** Access to and use of the SAS statistical analysis program. (1 cr) (F,Sp)

**Stat 4950. Directed Reading and Conference.** Prerequisite: Prior arrangement with specific instructor. (1-3 cr) (F,Sp,Su) ®

**Stat 5100 (CI, QI). Linear Regression and Time Series.** Methods for prediction and hypothesis testing in multiple linear regression models, including analysis of variance and covariance, logistic regression, introduction to time series, and signal processing. Prerequisite: Stat 2000 or 3000. (3 cr) (F)

**Stat 5110. Theory of Linear Models.** Theory and methods of correlation, regression, and least square analysis of experimental data. Prerequisites: Math 2210, 2250, or Math 2210, 2270; and Stat 3000. (3 cr) (F)

**Stat 5120. Categorical Data Analysis.** Analysis of categorical data, contingency tables, goodness of fit, random sampling, log-linear and logistic regression models, and sampling for proportions, as well as stratified and cluster sampling. Prerequisite: Stat 5100. (3 cr) (F)

**Stat 5200. Design of Experiments.** Design, analysis, and interpretation of experiments, split plots, incomplete blocks, confounding, fractional factorials, nested designs, two- and three-way analysis of variance, covariance, and multiple regression. Prerequisite: Stat 2000 or 3000. (3 cr) (Sp)

**Stat 5300 (QI). Statistical Process Control.** Techniques and applications of statistics in modern management of industrial processes. Control charts, acceptance sam-

pling, design of industrial experiments, and analysis of process failures. Prerequisite: Stat 2000 or 3000. (3 cr) (Sp)

**Stat 5600 (CI). Applied Multivariate Statistics.** Introduction to multivariate statistical procedures for data analysis. Topics include MANOVA, principal component analysis, factor analysis, clustering, and classification. Prerequisite: Stat 5100. (3 cr) (F)

**Stat 5810, Stat 5820. Topics in Statistics.** Prerequisite: Consent of instructor. (1-3 cr) (F) (1-3 cr) (Sp) ®

**Stat 5890 (CI). Problem Solving in Statistics.** Capstone course for Statistics majors, applying course material covered in the undergraduate major. Prerequisite: Permission of instructor. (3 cr) (Sp)

**Stat 5940. Directed Reading and Conference.** Prerequisite: Prior arrangement with specific instructor. (1-3 cr) (F,Sp,Su) ®

**Stat 5950H. Senior Honors Project.** A senior project, required for completion of the departmental honors program and developed under the direction of a departmental faculty member. Prerequisite: Permission of instructor. (1-4 cr) (F,Sp,Su)

**Stat 5970. Seminar.** Review of current literature and developments in the field of statistics. (1-3 cr) (F,Sp) ®

**\*Stat 6120. Generalized Linear Models.** Theory of generalized linear models and application to categorical data, and to regression-like and ANOVA-like data that do not meet the usual assumptions. Topics include link functions, error structures, deviance, quasi-likelihood estimation, and diagnostics. Prerequisites: Math 5720, Stat 5110. (3 cr) (Sp)

**\*Stat 6180. Time Series.** The domain and frequency domain time series analysis, including Box-Jenkins methods, spectral analysis and filtering, introduction to state space methodology. Prerequisites: Stat 5100, Math 5720. (3 cr) (Sp)

**\*Stat 6200. Analysis of Unbalanced Data and Complex Experimental Designs.** Contrasts; Type I, II, III, IV contrasts; sums of squares; and resulting tests. Random and mixed effects models for complex designs, such as split-plot, repeated measures, and hierarchical (nested) designs; expected mean square algorithm; and approximate F-tests. Prerequisite: Stat 5200. (3 cr) (F)

**\*Stat 6250. Graduate Internship/Co-op.** Educational work experience at the graduate level. Prerequisite: Permission of instructor. (1-8 cr) ®

**\*Stat 6510. Resampling Methods.** Covers theory and applications of computer intensive resampling methods: Bootstrap, Cross-validation, and Subsampling. Applications include hypothesis testing, confidence intervals, regression, time series, multivariate analysis, and nonparametric statistics. Prerequisite: Math 5710. (3 cr) (F)

**\*Stat 6520. Nonparametric Density Estimation and Smoothing.** Nonparametric density estimation and smoothing are generalizations of classical techniques that do not require such stringent distributional and functional form assumptions. This course covers theory, application, and implementation of histograms, frequency polygons, kernel-based methods, and spline-based methods. Prerequisites: Math 5710 and recommended concurrent enrollment in Math 5720. (3 cr) (Sp)

**\*Stat 6550. Statistical Computing.** Survey of algorithms and tools for modern statistical computing. Topics include simulation design and implementation, algorithms for linear regression and subset selection, smoothing algorithms, fast fourier transform, EM algorithm, numerical methods for maximum likelihood estimation, and neural networks. Prerequisites: Stat 5110, Math 5720, and knowledge of a programming language. (3 cr) (F)

**\*Stat 6560. Graphical Methods.** Statistical graphics and scientific visualization of one, two, and higher dimensional data. Well-chosen and designed graphics are vital in exploratory data analysis, model diagnostics, and data presentation. Includes spe-

cific methods and general principles, such as effective use of color and motion. Prerequisites: Stat 3000 and programming experience. (3 cr) (Sp)

**\*Stat 6600. Multivariate Analysis.** Statistical methods for analyzing multivariate data and the theory behind them. Topics include multivariate normal distribution and multivariate distributions derived from it, multivariate t-tests, regression, MANOVA, principal components and factor analysis, multidimensional scaling, classification, and cluster analysis. Prerequisites: Math 5720 and concurrent enrollment in Stat 5110. (3 cr) (F)

**Stat 6710. Mathematical Statistics I.** Modes of convergence of random variables, laws of large numbers, characteristic functions, and the central limit theorem. Prerequisite: Math 5720. (3 cr) (F)

**Stat 6720. Mathematical Statistics II.** Consistency, loss functions, risk, and notions of optimality of estimations. Hypothesis testing and confidence regions. Large sample theory, notions of robustness. Prerequisite: Stat 6710. (3 cr) (Sp)

**\*Stat 6810, Stat 6820. Topics in Statistics (Topic).** Prerequisite: Permission of instructor. (3 cr) (F) (3 cr) (Sp) ®

**\*Stat 6890. Practical Statistical Consulting.** Introduction to statistical consulting for graduate students, for faculty in other research departments, and for business, industry, and government. Prerequisite: Permission of instructor. (1-3 cr) (F,Sp,Su) ®

**\*Stat 6910. Seminar in Statistics.** Review of current literature and developments in statistics. Prerequisite: Permission of instructor. (1-3 cr) (F,Sp) ®

**\*Stat 6950. Directed Reading and Conference.** Prerequisite: Prior arrangement with specific instructor. (1-4 cr) (F,Sp,Su) ®

**Stat 6970. Thesis and Research.** Outlining and conducting research in statistics. Thesis preparation. (1-6 cr) (F,Sp,Su) ®

**Stat 6990. Continuing Graduate Advisement.** (1-3 cr) (F,Sp,Su) ®

**\*Stat 7110, Stat 7120. Linear Models (Topic).** (3 cr) (F) (3 cr) (Sp) ®

**\*Stat 7180, Stat 7190. Time Series Analysis (Topic).** (3 cr) (F) (3 cr) (Sp) ®

**\*Stat 7210, Stat 7220. Experimental Design (Topic).** (3 cr) (F) (3 cr) (Sp) ®

**\*Stat 7310, Stat 7320. Business and Industrial Statistics (Topic).** (3 cr) (F) (3 cr) (Sp) ®

**\*Stat 7510, Stat 7520. Nonparametric Statistics (Topic).** (3 cr) (F) (3 cr) (Sp) ®

**\*Stat 7550, Stat 7560. Computational and Graphical Statistics (Topic).** (3 cr) (F) (3 cr) (Sp) ®

**\*Stat 7610, Stat 7620. Multivariate Statistics (Topic).** (3 cr) (F) (3 cr) (Sp) ®

**\*Stat 7710, Stat 7720. Mathematical Statistics (Topic).** (3 cr) (F) (3 cr) (Sp) ®

**\*Stat 7730, Stat 7740. Bayesian Statistics and Decision Theory (Topic).** (3 cr) (F) (3 cr) (Sp) ®

**Stat 7810, Stat 7820. Topics in Statistics (Topic).** (1-3 cr) (F) (1-3 cr) (Sp) ®

**Stat 7970. Dissertation Research.** (1-15 cr) (F,Sp,Su) ®

**Stat 7990. Continuing Graduate Advisement.** (1-9 cr) (F,Sp,Su) ®

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® Repeatable for credit. Check with major department for limitations on number of credits that can be counted for graduation.

© This course is also offered by correspondence through Continuing Education Independent and Distance Education.

\*Offered by demand. Contact department.

\*\*Taught 2003-2004.

All course offerings are based on demand.