Mathematics and Science Education

In the College of Sciences and In the College of Education

For further information regarding programs, consult the following:

Ph.D. Program ....CRMSE
6475 Alvarado Rd., #236
619-594-4696
e-mail: mathsciphd@sdsu.edu
http://www.sci.sdsu.edu/crmse/msed/

M.A. Program ....Mathematics and Statistics
619-594-6191
Teacher Education
619-594-6131

Mathematics and Science Education Faculty

Joanne Lobato, Ph.D., Professor of Mathematics, Coordinator for Ph.D. Program
Nadine S. Bezuk, Ph.D., Professor of Teacher Education and Associate Dean of the College of Education
Leland L. Beck, Ph.D., Professor of Computer Science, Emeritus
Alexander W. Chizhik, Ph.D., Professor of Teacher Education
Lisa L. Clement Lamb, Ph.D., Professor of Teacher Education
Fred M., Goldberg, Ph.D., Professor of Physics, Emeritus
Richard A. Levine, Ph.D., Professor of Statistics
Stanley R. Maloy, Ph.D., Professor of Biology and Dean of the College of Sciences
Walter C. Oechel, Ph.D., Albert W. Johnson Distinguished Professor of Biology
Michael E. O'Sullivan, Ph.D., Professor of Mathematics
Randolph A. Philipp, Ph.D., Professor of Teacher Education
Chris L. Rasmussen, Ph.D., Professor of Mathematics
Kathy S. Williams, Ph.D., Professor of Biology
Matthew E. Anderson, Ph.D., Associate Professor of Physics
Janet S. Bowers, Ph.D., Associate Professor of Mathematics
Susan D. Nickerson, Ph.D., Associate Professor of Mathematics (M.A.T.S. Graduate Adviser)
Donna L. Ross, Ph.D., Associate Professor of Teacher Education
Rafaela M. Santa Cruz, Ph.D., Associate Professor of Teacher Education
Meredith E. Vaughn, Ph.D., Associate Professor of Teacher Education (Ph.D. Graduate Adviser)
Daniel Reinholz, Ph.D., Assistant Professor of Mathematics
Melissa M. Soto, Ph.D., Assistant Professor of Teacher Education
Dustin Thoman, Ph.D., Assistant Professor of Psychology
William C. Zahner, Ph.D., Assistant Professor of Mathematics

Committee for Mathematics Education

Nadine S. Bezuk, Ph.D., Professor of Teacher Education and Associate Dean of the College of Education
Lisa L. Clement Lamb, Ph.D., Professor of Teacher Education
Joanne Lobato, Ph.D., Professor of Mathematics
Randolph A. Philipp, Ph.D., Professor of Teacher Education
Chris L. Rasmussen, Ph.D., Professor of Mathematics
Janet S. Bowers, Ph.D., Associate Professor of Mathematics
Susan D. Nickerson, Ph.D., Associate Professor of Mathematics
Rafaela M. Santa Cruz, Ph.D., Associate Professor of Teacher Education
Daniel Reinholz, Ph.D., Assistant Professor of Mathematics
Melissa M. Soto, Ph.D., Assistant Professor of Teacher Education
William C. Zahner, Ph.D., Assistant Professor of Mathematics

Admission to Graduate Study

Students applying for admission should electronically submit the university application available at http://www.calstate.edu/apply along with the $55 application fee.

All applicants must submit admissions materials to SDSU Graduate Admissions.

Graduate Admissions

The following materials should be submitted as a complete package directly to:

Graduate Admissions
Enrollment Services
San Diego State University
San Diego, CA 92182-7416

(1) Official transcripts (in sealed envelopes) from all postsecondary institutions attended;

NOTE:

- Students who attended SDSU need only submit transcripts for work completed since last attendance.
- Students with international coursework must submit both the official transcript and proof of degree. If documents are in a language other than English, they must be accompanied by a certified English translation.

(2) GRE scores (http://www.ets.org SDSU institution code 4682);

(3) English language or IELTS score, if medium of instruction was in a language other than English (http://www.ets.org SDSU institution code 4682).

Mathematics and Science Education

The following admissions materials must be submitted electronically via DecisionDesk, http://gra.sdsu.edu/decisiondesk/. The Cal State Apply application must be completed prior to the mathematics and science education admissions materials.

(1) Mathematics and science education application;
(2) Three letters of recommendation attesting to capability to do graduate work in mathematics and science education;
(3) Personal statement;
(4) One copy of unofficial transcript;
(5) Curriculum vitae or resume.

Section I.
Master's Degree Programs

General Information

The Department of Mathematics and Statistics offers two specializations in its program of graduate study leading to a Master of Arts degree for teaching service. The specialization for community college teaching offers candidates a program designed to provide them with the mathematical breadth necessary to teach a wide variety of lower-division collegiate mathematics courses, while also providing them with a better understanding of the issues involved in teaching and learning mathematics. The specialization for secondary teaching offers coursework designed to strengthen the mathematical background of secondary teachers, to provide teachers with a deeper understanding of learning and teaching mathematics in grades 7-12, and to allow teachers the opportunity to analyze curriculum and evaluation efforts in a manner that can lead them to make reasoned judgments about curricular, testing, and instructional issues in grades 7-12 mathematics.

Courses described in this section may also be of interest to students seeking the Master of Arts degree in education with concentrations in elementary curriculum and instruction or secondary curriculum and instruction, offered by the School of Teacher Education.

Associateships

Graduate teaching associateships in mathematical sciences are available to qualified students. Support for qualified candidates may also be available through the School of Teacher Education, through the Center for Research in Mathematics and Science Education or through employment on faculty research grants. Applications are available from the appropriate campus offices.

All students must satisfy the general requirements for admission to the university with classified graduate standing, as described in Part Two of this bulletin.

Advancement to Candidacy

All students must satisfy the general requirements for advancement to candidacy as described in Part Four of this bulletin. In addition, students seeking the Master of Arts degree for teaching service must have passed a qualifying examination in mathematics education.

Specific Requirements for the Master of Arts Degree for Teaching Service in Mathematics
(Major Code: 17011) (SIMS Code: 776305)

In addition to meeting the requirements for classified graduate standing and the basic requirements for the master's degree as described in Part Four of this bulletin, the students must complete a graduate program of at least 30 units, 24 of which must be from the Department of Mathematics and Statistics. At least 15 of the 24 must be 600- and 700-numbered courses. A student's program must be prepared in conference with and approved by the graduate adviser.

The two specializations leading to the Master of Arts for teaching service require completion of a specific pattern of graduate units described below.

Specialization in Mathematics for Community College Teaching (SIMS Code: 776320). This specialization is designed to satisfy the requirements for teaching service at the community college level. Students must have completed a bachelor's degree in mathematics (or equivalent) before entering the program and must have completed six units selected from Mathematics 521A, 524, and 534A. The third course can be taken prior to entrance to the program or as part of the 30-unit degree requirements.

Plan A requires Mathematics 600, 601, 602, and Mathematics Education 603; six units selected from Mathematics 509, 720, Mathematics Education 604, 605, 606, 607; nine units of electives selected with the approval of the adviser; and Mathematics 799A, Thesis.

Plan B requires Mathematics 600, 601, 602, and Mathematics Education 603; nine units selected from Mathematics 509, 720, Mathematics Education 604, 605, 606, 607; and nine units of electives selected with the approval of the adviser. In addition, students must pass a comprehensive examination in mathematics education.

Specialization in Mathematics for Secondary Teaching (SIMS Code: 776351). This specialization is designed to strengthen the mathematical background of secondary teachers, while providing coursework to better understand the learning and teaching of mathematics in grades 7-12. Students should have the equivalent of a bachelor's degree in mathematics before entering the program.

Plan A requires Mathematics 524; Mathematics Education 603; three units selected from Mathematics 510, 600; three units selected from Mathematics 521A or 601; three units selected from Mathematics 534A or 602; six units selected from Mathematics 509, 720, Mathematics Education 604, 605, 606, 607; six units of electives selected with the approval of the adviser; and Mathematics 799A, Thesis.

Plan B requires Mathematics 524; Mathematics Education 603; three units selected from Mathematics 510, 600; three units selected from Mathematics 521A or 601; three units selected from Mathematics 534A or 602; nine units selected from Mathematics 509, 720, Mathematics Education 604, 605, 606, 607; and six units of electives selected with the approval of the adviser. In addition, students must pass a comprehensive examination in mathematics education.

Master of Arts Degree in Education

Concentration in Mathematics Education (K-8)
(Major Code: 17012) (SIMS Code: 331947)

The Master of Arts degree in education with a concentration in K-8 mathematics education is designed to provide teachers a deeper understanding of issues in learning and teaching mathematics in grades K-8, and increased knowledge of current trends, research, and assessment in mathematics education. Students can expect to acquire new perspectives and skills about mathematics teaching, specialized knowledge of children's mathematical understanding, and preparation for leadership among teachers in mathematics teaching.

1. **Prerequisites:** Applicant must have at least one year of teaching experience or consent of program coordinator, and must file an application for admission to both the university and the K-8 mathematics education program. Successful applicants must demonstrate personal, professional, and academic potential for success in this program. For specific admission criteria see the K-8 Mathematics Education Master of Arts program website at http://coe.sdsu.edu/departments/MathEd/master.htm.

2. **Core Program (12 units):**

MTHED 600	Teaching and Learning Mathematics in the Early Grades (Pre-K to 4) (3)	
MTHED 601	Teaching and Learning Mathematics in the Middle Grades (3)	
MTHED 603	Seminar on Learning Theories in Mathematics Education (3)	
TE 511	Assessment in Mathematics Education (3)	

3. **Electives (9 units):** With the approval of the adviser, select three courses from the following:

DLE 553	Language Assessment and Evaluation in Multicultural Settings (3)
DLE 601	Language Policies and Practices (3)
LDT 540	Educational Technology (3)
LDT 541	Educational Web Development (3)
LDT 570	Advanced Teaching with Technologies (3)
LDT 572	Technology for Course Delivery (3)
MTHED 604	Seminar on Teaching Issues in Mathematics (3)
MTHED 605	Algebra in the 7-14 Curriculum (3)
MTHED 606	Selected topics in 7-14 Mathematics Curriculum (3)
TE 790	Seminar in Teacher Education (3)

Or three units of a 500- or 600-level course approved by the program coordinator.

4. **Research (9 units):**

ED 690	Methods of Inquiry (3)
ED 795A	Seminar (3)
ED 795B	Seminar (3)

Section II.
Doctoral Program
http://www.sci.sdsu.edu/crmse/msed

General Information

San Diego State University and the University of California, San Diego, offer jointly a doctoral program in mathematics and science education. The program faculty at SDSU are members of the College of Sciences and the College of Education and are affiliated with the Center for Research in Mathematics and Science Education (CRMSE). They represent a number of different disciplines, including biology, mathematics, physics, psychology, statistics, and teacher education. The program faculty at UCSD, also an interdisciplinary group, are members of the Division of Physical Sciences (chemistry, mathematics, and physics) the Division of Biological Sciences, or the Division of Social Sciences (cognitive science, communication, education studies, psychology, and sociology). The program is administered under the College of Sciences at SDSU and under the Division of Physical Sciences at UCSD.

The research interests of the participating faculty members cover a wide range of issues in the learning and teaching of mathematics and the sciences. Graduates of the program will be qualified to take a variety of professional positions, including faculty appointments in universities, colleges, and community colleges; specialist positions in public school districts; and out-of-school employment in settings that require expertise in mathematics and science education.

Doctoral Faculty

The following faculty members of the cooperating institutions participate in the joint doctoral program, being available for direction of research and as departmental members of joint doctoral committees.

San Diego State University:
Coordinator: Joanne Lobato
Graduate Adviser: Meredith E. Vaughn
Staff Adviser: Deb Escamilla
Doctoral Program Members: *Biology*: Maloy, Oechel, Williams; *Computer Science*: Beck; *Mathematics*: Bowers, Lobato, Nickerson, O'Sullivan, Rasmussen, Reinholz, Zahner; *Physics*: Anderson, Goldberg; *Statistics*: Levine; *Teacher Education*: Bezuk, Chizhik, Lamb, Philipp, Ross, Soto, Vaughn

University of California, San Diego:
Coordinators: Jeff Rabin and Gabriele Wienhausen
Graduate Adviser: Chris Halter
Staff Adviser: Sherry Seethaler
Doctoral Program Members: Alàc, Barner, Brydges, Burgasser, Bussey, Daly, Datnow, Eggers, Halter, Heyman, Levin, Lo, Núñez, Quarfoot, Rabin, Remmel, Sawrey, Simon, Stevens, Weizman, Wienhausen

Admission to Doctoral Study

Applicants for admission to the doctoral program in mathematics and science education must meet the general requirements for admission to both universities with classified graduate standing as outlined in the respective current catalogs. Applicants must also meet the special requirements of this program. These include: (a) an acceptable baccalaureate degree in mathematics or science (or a related discipline); b) a master's degree, or its equivalent, in biology, chemistry, physics, or mathematics; (c) a GPA of at least 3.25 in the last 30 semester (or 45 quarter) units of upper division work and at least a 3.5 in the graduate work attempted; (d) good standing in the last institution attended; (e) suitable scores in quantitative, verbal, and analytic sections of the Graduate Record Examinations.

Students with a master's degree in mathematics education can also be considered for admission if they meet the following requirements: (a) a bachelor's degree in mathematics; (b) a master's degree in mathematics education that includes graduate level mathematics courses in analysis and algebra; and (c) coursework in geometry at the advanced undergraduate or graduate level. The GPA, GRE, and graduate standing requirements specified in the previous paragraph must also be met. Students entering the program with a master's degree in mathematics education are required to take additional mathematics courses as specified in "Specific Requirements for the Doctor of Philosophy Degree." Students with a master's degree in physics education, chemistry education, or biology education should contact the MSED program coordinators.

Students applying for admission to the doctoral program should electronically submit the university application available at http://www.calstate.edu/apply along with the $55 application fee.

All applicants must submit admissions materials separately to SDSU Graduate Admissions and to the Mathematics and Science Education Ph.D. Program.

Graduate Admissions

The following materials should be submitted as a complete package directly to:

Graduate Admissions
Enrollment Services
San Diego State University
San Diego, CA 92182-7416

(1) Official transcripts (in sealed envelopes) from all postsecondary institutions attended;

NOTE:
- Students who attended SDSU need only submit transcripts for work completed since last attendance.
- Students with international coursework must submit both the official transcript and proof of degree. If documents are in a language other than English, they must be accompanied by a certified English translation.

(2) GRE scores (http://www.ets.org SDSU institution code 4682);

(3) English language score, if medium of instruction was in a language other than English (http://www.ets.org SDSU institution code 4682).

Mathematics and Science Education

The following materials should be delivered or mailed to:

Mathematics and Science Education Ph.D. Program
CRMSE, San Diego State University
6475 Alvarado Road, Suite 206
San Diego, CA 92120-5013

(1) Application for doctoral program in mathematics and science education
(http://www.sci.sdsu.edu/CRMSE/msed/crmse_app02.doc);

(2) Mathematics and Science Education recommendation form as cover sheet
(http://www.sci.sdsu.edu/CRMSE/msed/Recommend_Form-CoS.doc);

(3) At least three letters of recommendation.

Specific Requirements for the Doctor of Philosophy Degree

(Major Code: 08997) (SIMS Code: 993501)

Residency Requirements. After formal admission to the doctoral program, the student must complete a 36-unit residency at the University of California, San Diego, of which a maximum of 12 units can be upper division undergraduate courses (100 level). Lower division undergraduate courses do not count toward residency. Students must also complete an 18-unit residency at San Diego State University. The residency requirements cannot be replaced by coursework taken elsewhere.

Language Requirement. There is no formal language requirement for the program.

Course Requirements. All students admitted into the doctoral program will fulfill the following requirements. Any alternative method of fulfilling these requirements must be approved by the graduate advisers.

A. Four research apprenticeship experiences:
SDSU: MSE 801 *and*
SDSU: MSE 802 *and* UCSD: MSED 295, *and*
SDSU: MSE 820 *or* UCSD: MSED 298.

B. Core courses in Mathematics or Science Education.
UCSD: MSED 296A, 296B, 296C *and*
SDSU: MTHED 603.
Science Education students must also take UCSD: MSED 290.
Mathematics Education students must select two of the following additional courses: SDSU: MTHED 600, 601, 604, 605, 606, 607.

C. Three courses on quantitative and qualitative research methods.
SDSU: MSE 810 *and* one of the following sequences:
UCSD: EDS 287, 288 *or*
UCSD: PSYC 201A, 201B *or*
UCSD: MA 282A, 282B *or*
SDSU: PSY 670A, 670B.

D. Two courses in cognitive science at UCSD selected from:
   COGS 102A *or* 234; COGS 102B, 200, 260; *or one* of COGS 101A, 101B, 101C.
E. One teaching practicum.
   SDSU: MSE 805, 806, *or* 807 *or*
   UCSD: EDS 129A/139, *or* Discipline 500 *or* MSED 295.
F. Two courses from different categories are selected with advisers according to the student's needs and background:
   (1) Philosophy and History. UCSD: PHIL 145, 146, 147, 209A; HISC 106, 107, 108, 109, 160/260, 163/263, 164/264, or 165/265.
   (2) Sociology. UCSD: SocG 270, SocB 117/EDS 117, or SocC 126/EDS 126.
   (3) Mathematics and Science: Graduate level courses in biology, chemistry, mathematics, or physics.
   (4) Teaching Experience: An option for students who have not yet had teaching experiences at both the K-12 and collegiate levels is to take a second teaching practicum.
   (5) Other. Other types of courses (at the graduate or upper division undergraduate level) can be approved by the advisers if they contribute to a coherent program.
G. Three doctoral research courses:
   SDSU: MSE 830, 899 *and*
   UCSD: MSED 299.

Beyond these requirements, no specified number of courses is required for the doctoral degree. It is expected, however, that all the doctoral students will supplement the requirements with electives that contribute to individual career objectives.

Additional Requirements for Students Entering with a Master's Degree in Mathematics Education. Students who are admitted into the doctoral program with a master's degree in mathematics education will increase the breadth and depth of their mathematical knowledge by fulfilling the requirements specified for Option A *or* Option B:

Option A.

UCSD: MATH 240A, 240B, 240C *and*

Pass the UCSD comprehensive examination on analysis at the master's level *and*

One graduate algebra course: UCSD: MATH 200A or SDSU: MATH 627A or 623. MATH 623 can only be selected if the student has already taken a graduate level abstract algebra course.

Option B.

Select two of SDSU: MATH 627A, 627B, 623, *and*

Pass the SDSU comprehensive examination on algebra at the master's level *and*

UCSD: MATH 240A

Whether the student selects Option A or Option B, the year-long sequence in algebra or analysis must be taken in Year 1 of the doctoral program. All of the requirements for Option A or Option B must be completed prior to the second year examination; however, students are strongly encouraged to fulfill all of the requirements in Year 1. A grade of B or better must be earned in each course.

Examinations. Students in the doctoral program will be evaluated at the following levels:

(1) *First Year Evaluation.* The student's ability to master graduate level course material may be assessed after completion of no more than 24 semester units of coursework. This evaluation may take place not later than the third semester of the student's enrollment in the program. The evaluation will be based on the student's performance in coursework and on indicated research competence, and it will be undertaken by the student's advisory committee together with instructors from the student's first year courses.

(2) *Comprehensive Examinations.* At the end of the second year, the student will take a written comprehensive examination in general cognition and an oral examination on issues of learning pertinent to the student's area of specialization.

(3) *Oral Examination.* During the third year in the program, the student will make an oral presentation to the dissertation committee to accompany a written proposal for the doctoral thesis. The student will be questioned on both the topic of the investigation and on the proposed research methodology. Upon successful completion of this presentation, the student will be recommended for advancement to candidacy for the doctoral degree.

(4) *Dissertation Defense.* After completion of the dissertation, the candidate will present a public defense of the doctoral dissertation. A copy of the dissertation must be made available to the doctoral faculty at both institutions four weeks prior to the defense. Copies of the abstract of the dissertation, along with the announcement of the defense, must be publicly available four weeks before the defense. The student's dissertation committee will make a recommendation to the graduate deans to pass or fail the student.

Faculty Advisers. Upon admission to the doctoral program, the program directors will assign each student a faculty adviser at both universities. The faculty advisers will serve as advisers until the student's dissertation committee is appointed.

Dissertation Committee. The dissertation committee will be composed of five members with at least two faculty members from each campus. The student will select members of the dissertation committee in consultation with program faculty and the graduate advisers.

Dissertation. Following the successful completion of all prescribed coursework and qualifying examinations, the major remaining requirement for the Ph.D. degree will be the satisfactory completion of a dissertation consisting of original research carried out under the guidance of the major professor. Approval of the completed dissertation attests that an organized investigation that expands the frontiers of knowledge and understanding in mathematics and science education has been carried out.

Award of the Degree. The Doctor of Philosophy degree in Mathematics and Science Education will be awarded jointly by the Regents of the University of California and the Trustees of The California State University in the names of both cooperating institutions.

Financial Support

San Diego State University and the University of California, San Diego have a number of research and teaching associateships available to support students admitted to the Joint Doctoral Program. All students applying to the program will be considered for financial support.

Courses Acceptable for Master's and Doctoral Degree Programs in Mathematics and Science Education (MTHED) (MSE)

Refer to Courses and Curricula and Regulations of the Division of Graduate Affairs sections of this bulletin for explanation of the course numbering system, unit or credit hour, prerequisites, and related information.

Mathematics and Science Education (MTHED)
GRADUATE COURSES

MTHED 600. Teaching and Learning Mathematics in the Early Grades (Pre-K to 4) (3)
Prerequisites: Mathematics Education 603 or 604 and K-12 teaching experience.
Research in teaching and learning mathematics in preschool through grade four. Innovative early childhood mathematics curricula, promising instructional practices. Assessment techniques to guide instruction.

MTHED 601. Teaching and Learning Mathematics in the Middle Grades (3)
Prerequisites: Mathematics Education 604 and K-12 teaching experience.
Research on teaching and learning mathematics in grades five through eight. Innovative middle grades mathematics curricula, promising instructional practices. Assessment techniques to guide instructions.

MTHED 603. Seminar on Learning Theories in Mathematics Education (3)
Prerequisite: Consent of instructor or graduate adviser.
Application of several major learning theories (e.g. behaviorism, structuralism, radical constructivism, information processing, and sociocultural perspectives) to research on the learning and teaching of mathematics.

MTHED 604. Seminar on Teaching Issues in Mathematics (3)
Prerequisite: Consent of instructor or graduate adviser.
Mathematics education research pertaining to teaching of mathematics. Readings chosen to bridge theory and practice divide.

MTHED 605. Algebra in the 7-14 Curriculum (3)
Prerequisite: Consent of instructor or graduate adviser.
Curricular change in algebra, with attention to experimental curricula, to research on learning of algebra, and to influences of technology. Implications for instruction.

MTHED 606. Selected Topics in 7-14 Mathematics Curriculum (3)
Prerequisite: Consent of instructor or graduate adviser.
Curricular change in school mathematics, to include geometry, probability, and statistics, with attention to contemporary curricula, to research on learning and teaching in those areas, and to the influences of technology. Implications for instruction.

MTHED 607. Seminar on Research in Undergraduate Mathematics Education (3)
Prerequisite: Consent of instructor or graduate adviser.
Research in undergraduate mathematics education and its implications for teaching. Topics include research on student thinking on concepts from calculus through abstract algebra and the teaching and learning of proof.

Mathematics and Science Education (MSE)
DOCTORAL COURSES

MSE 801. Faculty Research (1) Cr/NC
Prerequisite: Admission to doctoral program in Mathematics and Science Education.
Issues of learning with reference to how they are addressed by doctoral faculty. Students will interview and write a one-page statement of research interests for each of eight doctoral faculty members.

MSE 802. Orientation Practicum (1-3) Cr/NC
Prerequisite: Admission to doctoral program in Mathematics and Science Education.
Experience with research programs will introduce students to a variety of research questions and approaches. One research program per unit; minimum three units required in program. May be repeated with new content. See *Class Schedule* for specific content. Maximum credit four units applicable to an advanced degree.

MSE 805. Supervised Teaching of Teacher Preparation Courses (3) Cr/NC/RP
Prerequisite: Admission to doctoral program in Mathematics and Science Education.
Students will plan and teach, under supervision, a course that prepares prospective teachers to teach mathematics or science at either the elementary or secondary level.

MSE 806. Supervised School Practicum (3) Cr/NC/RP
Prerequisite: Admission to doctoral program in Mathematics and Science Education.
School-based project focusing on inservice of teachers or on curriculum development, or work with a school district administrator or mathematics or science.

MSE 807. Specially Designed Practicum (3) Cr/NC/RP
Prerequisite: Admission to doctoral program in Mathematics and Science Education.
Practical experience to assist students in gaining experience in career they have selected.

MSE 810. Seminar in Research Design (3)
Prerequisites: Admission to doctoral program in Mathematics and Science Education; Psychology 670A, and consent of instructor.
Issues such as analysis of protocols, problems of measurement in evaluation of learning, development, and assessment of cognitive models in learning in mathematics and science.

MSE 820. Research Project (3-6) Cr/NC/RP
Prerequisite: Admission to doctoral program in Mathematics and Science Education.
Participation in an ongoing research project and development of a related study.

MSE 830. Research Seminar (3)
Prerequisite: Successful completion of qualifying examination.
Students and faculty present ongoing research for discussion and critique.

MSE 897. Doctoral Research (1-15) Cr/NC/RP
Prerequisite: Mathematics and Science Education 820.
Independent investigation in general field of the dissertation.

MSE 898. Doctoral Special Study (1-8) Cr/NC/RP
Prerequisites: An officially constituted doctoral committee and advancement to candidacy.
Individual study in the field of specialization.

MSE 899. Doctoral Dissertation (1-15) Cr/NC/RP
Prerequisites: An officially constituted dissertation committee and advancement to candidacy.
Preparation of the dissertation for the doctoral degree. Enrollment is required during the term in which the dissertation is approved.

For additional courses applicable to the Master of Arts degree for Teaching Service see:
Mathematics 600. Geometrical Systems
Mathematics 601. Topics in Algebra
Mathematics 602. Topics in Analysis
For additional courses related to mathematics education see:
Teacher Education 511. Assessment in Mathematics Education

Courses for Mathematics Education (MATH)

Refer to Courses and Curricula and Regulations of the Division of Graduate Affairs sections of this bulletin for explanation of the course numbering system, unit or credit hour, prerequisites, and related information.

UPPER DIVISION COURSES

NOTE: Proof of completion of prerequisites required for all upper division courses: Copy of transcript.

MATH 501A. Reasoning: Place Value and Arithmetic Operations (1)
Prerequisites: Teaching credential and consent of instructor.
Place value and its role in development and understanding of arithmetic operations, to include numeration systems, student methods, standard algorithms, and mental computation.

MATH 501B. Reasoning: Rational Numbers and Real Number Systems (1)
Prerequisites: Teaching credential and consent of instructor.
Rational numbers and structure of real number system, to include meanings and models for fractions with attention to operations on rational numbers.

MATH 504A. Reasoning: Quantities and Mathematical Relationships (1)
Prerequisites: Teaching credential and consent of instructor.
Reasoning about measurable characteristics in problem context. and relationships among these measurements. Additive, multiplicative reasoning, and proportional reasoning in middle grades.

MATH 504B. Reasoning: Algebra and Nature of Change (1)
Prerequisites: Teaching credential and consent of instructor.
Pattern searching, generalizing, graphing to represent quantitative relationships, and role of these topics in preparing elementary and middle school students for algebra.

MATH 506A. Algebra in the Middle Grades I (3)
Prerequisites: Teaching credential and consent of instructor.
Mathematical foundations that underlie concepts and procedures emphasized in algebra I and algebra II as taught at middle and high school level, to include focus on real number system, ratios, proportional reasoning, equality, number theory, and proof.

MATH 506B. Algebra in the Middle Grades II (3)
Prerequisites: Mathematics 506A, practicing teachers with valid teaching credential, and consent of instructor.
Mathematical foundations that underlie concepts and procedures emphasized in algebra I and algebra II as taught at middle and high school level, to include focus on functions in context of relations, patterns, and graphing.

MATH 507A. Functions and Study of Change I (2)
Prerequisites: Mathematics 506B, practicing teachers with valid teaching credential, and consent of instructor.
Mathematical ideas surrounding linear functions and change to include proportionality, slope, and graphing. Arithmetic and geometric sequences.

MATH 507B. Functions and Study of Change II (3)
Prerequisites: Mathematics 507A, practicing teachers with valid teaching credential, and consent of instructor.
Mathematical ideas surrounding nonlinear functions and variable rates of change to include quadratic and exponential situations.

GRADUATE COURSES

MATH 600. Geometrical Systems (3)
Prerequisites: Mathematics 521A and an upper division course in geometry.
Ordered and affine geometries, decompositions, dilations. Projectivities and projective space. Absolute geometry, isometries, groups generated by inversions.

MATH 601. Topics in Algebra (3)
Prerequisites: Mathematics 521A and 534A.
Unique factorization domains, rings and ideals, groups, algebraic field extensions. A course designed for secondary school teachers.

MATH 602. Topics in Analysis (3)
Prerequisites: Mathematics 521A and 534A.
Topics in analysis, including the real number system, convergence, continuity, differentiation, the Riemann-Stieltjes integral, complex analysis, designed to give the secondary teacher a broad understanding of the fundamental concepts.

Mechanical Engineering
Refer to "Engineering" in this section of the bulletin.

Molecular Biology
Refer to "Biology" in this section of the bulletin.