COLLEGE OF NATURAL AND APPLIED SCIENCES

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Interdisciplinary Programs

Master of Natural and Applied Sciences
(includes accelerated master's opportunity)
Arbindra Rimal, Graduate Director

Department of Agriculture
W. Anson Elliott, Department Head
Arbindra Rimal, Graduate Director

Master of Science, Plant Science
(includes accelerated master's opportunity)
Master of Science in Education, Secondary Education

Department of Biology
S. Alicia Mathis, Department Head
D. Alexander Wait, Graduate Director

Master of Science, Biology
(includes accelerated masters opportunity)
Master of Science in Education, Secondary Education

Department of Chemistry
Alan Schick, Department Head
Erich Steinle, Graduate Director

Master of Science, Chemistry
(includes accelerated master's opportunity)
Master of Science in Education, Secondary Education

Department of Computer Science
Lloyd A. Smith, Department Head

Department of Fashion and Interior Design
Paula A. Kemp, Acting Department Head

Master of Science in Education, Secondary Education

Department of Geography, Geology and Planning
Thomas G. Plymate, Department Head
Robert T. Pavlowsky, Graduate Director

Master of Science, Geospatial Sciences in Geography and Geology
(includes accelerated master's opportunity)
Master of Science in Administrative Studies, Environmental Management Option
Master of Science in Education, Secondary Education
Graduate Certificate: Geospatial Information Science
(offered jointly with the Missouri University of Science and Technology (MS&T)

Department of Mathematics
Yungchen Cheng, Department Head

Master of Science, Mathematics
(includes accelerated master's opportunity)
Master of Science in Education, Secondary Education

Department of Physics, Astronomy and Materials Science
Pawan Kumar Kahol, Department Head
Kartik Ghosh, Graduate Director

Master of Science, Materials Science
(includes accelerated master's opportunity)
Master of Science in Education, Secondary Education

SCIENCE EDUCATION COURSES

(Courses may be used in various programs in the College of Natural and Applied Sciences)

SCI 605 Intellectual Foundations of Science and Technology. 3(3-0), S. An historical and philosophical examination of the origins and the development of science and technology. The differences between science and technology, their interrelationships in modern times, and the impact of each of these on society will be considered. May be taught concurrently with SCI 505. Cannot receive credit for both SCI 505 and SCI 605.

SCI 685 Topics in Science Education. 1-4 D. A variable content course for offering selected topics of interest to science teachers in the elementary, middle, or secondary schools; or in college classrooms. May be repeated up to 6 hours when the topic varies. No more than 6 hours may be counted toward a degree. May be taught concurrently with SCI 580. Cannot receive credit for both SCI 685 and SCI 580.

SCI 780 Advanced Topics in Science Education. 1-4, D. Prerequisite: 12 hours of graduate coursework. A variable content course for offering selected topics of interest to science teachers in the elementary, middle, or secondary schools; or in college classrooms. May be repeated up to 6 hours when the topic varies. Maximum of 6 hours may be counted toward degree.

MASTER OF SCIENCE, ADMINISTRATIVE STUDIES: ENVIRONMENTAL MANAGEMENT OPTION

PROGRAM DESCRIPTION

Several departments in the College of Natural and Applied Science participate in the Master of Science, Administrative Studies (MSAS) degree by contributing courses in the Environmental Management Option. The MSAS is an interdisciplinary program composed of courses from departments and colleges across campus. The program, which includes a significant online component, is administered by a faculty committee and housed in the Graduate College. For more information, see the full MSAS program listing in the Graduate College section of this catalog.

MASTER OF NATURAL AND APPLIED SCIENCE (Interdisciplinary Program)

Arbindra Rimal, Program Director
Karls Hall, Room 219; Phone (417) 836-5094
Arbindra Rimal@missouristate.edu

PROGRAM DESCRIPTION

The Master of Natural and Applied Science program at Missouri State University is designed to provide those working in an environment where scientific knowledge is a priority, such as science teaching and scientific applications, the opportunity to expand their knowledge and experiences consistent with their professional goals and objectives through an interdisciplinary program of study in the natural and applied sciences. The curriculum will consist of formal courses in one or more areas of concentration, professional advisement, graduate seminar or research options (e.g., master's thesis), as well as incorporating the candidate's background, goals, and objectives.

PROGRAM OBJECTIVES

1. To increase both the depth and breadth of knowledge in one or more of the areas in natural sciences for understanding and appreciation of the interdisciplinary nature of science.
2. To provide advanced training and education for expanding current scientific knowledge and capabilities.
3. To provide a base of knowledge or enhancement in an area of natural science outside an original field of study.

ADMISSION REQUIREMENTS

Students admitted in full standing must meet the following requirements.

1. The student must have a bachelor's degree from a college or university accredited by agencies recognized by Missouri State University or equivalent education from a foreign university.
2. The student must have an overall GPA of 3.00 on a 4.00 scale for the last 60 hours of course work, AND, a score of 475 or higher on either the verbal or the quantitative section of the Graduate Record Examination (GRE), and a score of not less than 400 on the other sections; AND, be recommended in writing by both the department head of the student's desired major area and the Dean of the College of Natural and Applied Sciences, AND, have the approval of the Dean of the Graduate College.

3. International applicants are also required to submit a score of not less than 550 on the paper-based or a comparable score of 213 on the computer-based TOEFL, with a minimum of 50th percentile on the Listening Comprehension Section.

4. The student must have an undergraduate background of at least 20 semester hours in the natural and applied sciences.

DEGREE REQUIREMENTS (minimum of 32 hours)

1. **Advisory Committee**. Initially, each student will be advised by the departmental coordinator of graduate studies from the student's primary emphasis area. As soon as possible, the student will select a graduate faculty member from that department to chair a graduate advisory committee consisting of at least three faculty members that includes a faculty member from the student's secondary emphasis area and includes faculty members from at least two departments. This committee will supervise the remainder of the student's program.

2. **Program of Study**. This unique interdisciplinary masters program requires more than one area of concentration. Each individualized program will be structured by the advisory committee in consultation with the student. The academic background, professional experience, academic objectives, and personal needs will be considered in establishing the individual's program.

   Students may elect areas of primary emphasis in the following departments; Agriculture, Biology, Chemistry, Computer Science, Fruit Science, Geography, Geology and Planning, Mathematics, and Physics, Astronomy and Material Science.

   Students may elect areas of secondary emphasis in the following departments; Agriculture, Biology, Chemistry, Computer Science, Fruit Science, Geography, Geology and Planning, Mathematics, and Physics, Astronomy and Material Science.

3. **Course Requirements.** The student must select a primary emphasis area consisting of at least 16 hours of courses selected from one department in the College of Natural and Applied Sciences. The student must also select a secondary emphasis area of 9-16 hours consisting of graduate courses approved by the student's advisory committee. In total, the student must complete at least 32 hours of course work, of which at least 16 must be in courses open only to graduate students (numbered 700 or above).

4. **Grade Point Average.** A GPA of at least 3.00 on a 4.00 scale for all graduate work at Missouri State and course work transferred from other institutions is required.

5. **Non-Thesis/Thesis Requirements.** A student will be required to complete either the Non-Thesis Option or the Thesis Option.

   Non-Thesis Option: The Non-Thesis option requires the completion of a minimum of one semester course which shall require an extensive research paper or creative work. The student's advisory committee must approve the final research paper and complete a Seminar Report form that is submitted to the academic department chosen as the major area of concentration and subsequently to the Graduate College for the approval of the Dean.

   Thesis Option: The Thesis option requires the completion of a research thesis supervised by the student's advisory committee. The thesis shall be approved by the advisory committee and by the Dean of the Graduate College before the degree is granted. A maximum of six hours of thesis credit can be applied toward the minimum hours required for the master's degree.

6. **Comprehensive Examination.** After the course work has been completed, and upon approval of the advisory committee, a written comprehensive examination will be administered and evaluated by the advisory committee. This examination must be passed by the candidate before a degree will be given.

7. **Time Limit.** The student must complete all requirements within an eight-year period (exclusive of the time spent in the United States Armed Forces).

ACCELERATED MASTER'S DEGREE OPTION

Eligible Missouri State University undergraduate students in a major in the College of Natural and Applied Sciences may apply for preliminary acceptance into the Master of Natural and Applied Science program after admission requirements for the accelerated master's option have been satisfied. If accepted, undergraduate courses chosen from approved 500-level courses or higher may be counted toward both the undergraduate and graduate degrees, with a maximum of 12 credit hours. This option offers an opportunity for CNAS majors whose goals, academic capabilities, and career planning include graduate work, to complete the requirements for the master's degree in less time than would otherwise be possible. Contact the MNAS Program Director for further information and guidelines.

All requirements for the implemented undergraduate program should be met for graduation from the undergraduate degree program. A student may fully be admitted to the Graduate College upon completion of the requirements for the baccalaureate degree. All requirements for the implemented master's program should be met for graduation from the master's degree program. A student must be admitted into the Accelerated Master's Degree Program at Missouri State University in order to begin taking graduate course work for dual credit. Admission requires approval from the Graduate Program Advisor, Department Head of the undergraduate program, and the Dean of the Graduate College. Students admitted into the Accelerated Master's Degree program will not be fully admitted into the Graduate College until completion of their undergraduate degree and fulfillment of all other requirements for admission to the Graduate College (such as the Graduate Record Examination). Student should be awarded the bachelors degree upon completion of the minimum of 125 hours of combined graduate and undergraduate course work and degree specific requirements.

Admission Requirements for the Accelerated Master's Option

1. Junior standing and a GPA 3.00 or better.
2. A supportive recommendation from the student's undergraduate advisor.
3. Acceptance of applicant by a graduate faculty member who agrees to serve as the student's graduate mentor.
4. Acceptance of the applicant under the accelerated master's option by the MNAS Advisory Committee and MNAS Program Director.

NOTE: The Graduate Record Exam (GRE) must be taken prior to completing the bachelors degree. Refer to item 2 under Admission Requirements for regular MNAS degree.

DEPARTMENT OF AGRICULTURE

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GRADUATE FACULTY

Professor: W. Anson Elliott, Ben D. Fuqua, Lyndon N. Irwin, Martin L. Kaps, Michael P. Roling, Dennis L. Schmitt, Pamela Trewatha
Associate Professor: Clydette Alsup, Michael G. Burton, James B. Hutter, Wenping Qiu, Arbindra P. Rimal, Gary W. Webb, Karl L. Wilker
Assistant Professor: Benjamin M.Onyango, Elizabeth L. Walker
Emeritus Professor: Harry R. James, J.N. Smith, Charles E. Stufflebeam, Howard G. Townsend, Jr.

MASTER OF SCIENCE, PLANT SCIENCE

Arbindra Rimal, Program Director
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PROGRAM DESCRIPTION

This program is designed to prepare students to work in a wide range of jobs related to the production and economic uses of plants. Employment opportunities include the areas of crop, fruit and vegetable production, biotechnology, nursery and seed production, landscape management, wine production, environmental preservation, agribusiness, teaching, research, and extension education. Students may also continue their education in a doctoral program.

The Master of Science in Plant Science is offered as an interdepartmental major from the departments of Agriculture, Biology, Chemistry, and Fruit Science. Together with the plant science program coordinator, the student selects an advisor from one of the four departments. The student and advisor design an individual program of study, selecting courses which will help the student to achieve his/her career goals.

During the first semester, the student declares an area of specialization and begins to pursue a research problem (project) with close supervision of a graduate faculty advisory committee. Research areas include fruit production, soils and plant nutrition, ornamental plants and landscaping, plant physiology, enology and viticulture, crop management systems, plant genetics, and economic botany.

Most course work is usually completed by the end of the second or third semester, and the research and thesis completed after four or five semesters. A comprehensive exam is taken during the second year.

ADMISSION REQUIREMENTS

Students admitted to the plant science program in full standing must meet the following requirements.

1. The student must meet all Graduate College Admission requirements (See Admission to Graduate Study under Graduate College section of catalog). Students who do not meet the grade point standards outlined, but are admitted on the basis of their GRE scores, will be required to complete a minimum of 9 hours of specified graduate courses with a GPA of at least 3.00 before being approved for an Advisory-approved Program of Study in the program.
2. The student must submit Graduate Record Examination (GRE) scores from the General Test portion.
3. International applicants are also required to submit a score for the Test of English as a Foreign Language (TOEFL) of not less than 550 on the paper-based or a comparable score of 213 on the computer-based with a minimum of 50th percentile on the Listening Comprehension Section.
4. The student must possess an undergraduate degree with a background in an appropriate natural or applied science including one semester of genetics and one semester of organic chemistry or equivalents thereof. Applicants lacking the background courses may be admitted, but will be required to complete any of these deficiencies with appropriate course work.
5. The student must receive a positive evaluation from the Graduate Coordinator of the Plant Science program before being recommended to the Graduate College for admittance into the program.

GRADUATE ASSISTANTSHIPS

Evaluation of applications for assistantships begins on March 1 (fall assistantships) and October 1 (spring assistantships), and will continue until positions are filled. Applicants must first be accepted into the program, and files must be complete to be considered.

RETENTION REQUIREMENTS

To remain in the program, students must maintain a GPA of 3.00 and make satisfactory progress on the thesis research.

MISSOURI STATE UNIVERSITY

ACCELERATED MASTER'S DEGREE OPTION

Missouri State University majors in Agriculture, Biology, and Chemistry have the option to apply for preliminary acceptance into the MS in Plant Science program if they meet the requirements of the accelerated master's option. This option is tailored to those undergraduates who have acquired considerable plant science-related research experience in a laboratory through the departments of Agriculture, Biology or Chemistry at Missouri State University. Students who are accepted to the accelerated program will be able to count a maximum of 12 credit hours of 600-or higher level course towards both their undergraduate and graduate degrees. The courses must be in the area of economic botany, plant physiology, plant genetics, crop management systems, plant nutrition, soils, chemistry, ecology, fruit production, viticulture, enology, or ornamental plants and landscaping. Courses to be counted toward both degrees must be identified jointly in agreement with the undergraduate advisor, the student's research mentor, and the Plant Science Program Director. This option will enable Agriculture, Biology or Chemistry majors to potentially meet the requirements for the MS in Plant Science degree within two semesters following the completion of the undergraduate degree. Contact the Plant Science Program Director for details and additional information.

To be allowed to enroll in a course which is counted toward both the undergraduate and graduate degree, the student must be accepted as an advisee by a graduate faculty member and must be admitted into the accelerated program and have the permission of his/her undergraduate advisor, the Plant Science Program Director and the Dean of the Graduate College. These signature approvals are shown on the Mixed Credit Form which is required prior to the end of the Change of Schedule Period for the selected semester.

Admission Requirements for the Accelerated Master's Option

1. Junior or senior standing with at least 60 credit hours with an overall GPA 3.50 or better.
2. A minimum of 25 credit hours of undergraduate hours relevant to plant biology (as determined by the undergraduate advisor, the student's research mentor, and the Plant Science Program Director) with a GPA of 3.50 or higher.
3. Laboratory research experience relevant to plant science under the direction of a faculty member in Agriculture, Biology or Chemistry at Missouri State University.
4. Acceptance of the student as an advisee by a member of the MS in Plant Science Graduate Faculty.
5. Approval by the MS in Plant Science Graduate Advisory Committee.

DEGREE REQUIREMENTS

1. **Graduate Advisory Committee**. Initially, each admitted student will be advised by the graduate coordinator of the Plant Science program. As soon as possible, the student, in conjunction with the graduate coordinator, will select a graduate faculty member from one of the four participating departments to chair a graduate advisory committee. Together with the student, the chairperson of the graduate advisory committee will select a minimum of two additional graduate faculty members from one or more of the participating departments. This committee will supervise the remainder of the candidate's program.
2. **Program of Study.** If not a part of the student's previous academic experience, courses in plant physiology (BIO 644) and biometry (BIO 650) or applied statistics (MTH 645) must be completed within the first year of the program. The remainder of the candidate's program will be structured by the advisory committee in consultation with the student. Academic background, professional experience, and career objectives will be considered in establishing the individual's program.
3. **Course Requirements.** The student is required to successfully complete a minimum of 32 hours. Course work taken from the Departments of Agriculture, Biology, Chemistry, Fruit Science, or Mathematics must total at least 23 hours with a minimum of 16 hours from courses numbered 700 through 799 inclusive.
4. **Colloquium.** Two hours of credit must be earned in AGF 700, Plant Science Colloquium.
5. **Electives.** Upon approval of the advisory committee, graduate courses from related fields may be selected to a maximum of 9 hours within the 32-hour degree requirement.
6. **Research Requirement**. Maximum credit toward the 32-hour degree requirement is 6 hours of research and 6 hours of thesis. Research and/or Thesis credit may be elected from the Departments of Agriculture, Biology, Chemistry, and/or Fruit Science with the approval of the graduate Coordinator as recommended by the Graduate Advisory Committee. Submission of a thesis is a specific requirement for the degree. The purpose of the thesis is to demonstrate competence in scientific research and the ability to: choose a research topic of scientific importance, conduct a comprehensive literature search of the problem, design and implement a plan of research, collect and interpret scientific data, and communicate results and findings to peers. An oral defense of the thesis is required.
7. **Qualifying Examination.** A written qualifying examination will be administered after most of the course work has been completed. This examination must be passed by the candidate before a degree will be given.

MASTER OF NATURAL AND APPLIED SCIENCE

See program description listed separately under the College of Natural and Applied Sciences. (Accelerated masters opportunity available.)

MASTER OF SCIENCE IN EDUCATION, SECONDARY EDUCATION: AGRICULTURE AREA OF EMPHASIS

Contact Dr. James Hutter and see program requirements for the M.S.Ed., Secondary Education under Interdisciplinary Graduate Programs, page 61.

AGRICULTURE REQUIREMENTS

AGE 718 Topics in Agricultural Education	3 hrs
Additional course work in Agriculture	12 hrs
	TOTAL 15 hrs

AGRICULTURE COURSES

AGR 790 Introduction to Agricultural Research Methods. 3(3-0), D. Prerequisite: permission of instructor. This course is designed to provide an introduction to the process of research. The course will address planning, conducting, and reporting research; and development of good consumers of research.

AGR 797 Seminar. 1(1-0), D. Prerequisite: permission of advisor. In-depth study in an area of agriculture, culminating in an extensive scholarly presentation. May be repeated to a total of three hours.

AGR 798 Research. 1-6, F,S,Su. Prerequisite: permission of instructor. Supervised research in agriculture. May be repeated, but not more than 6 hours may be counted toward the 32 hour degree.

AGR 799 Thesis. 1-6, F,S,Su. Prerequisite: permission of instructor. Demonstration of the capacity for research and independent thought culminating in a thesis. May be repeated. A minimum of 6 hours will be applied toward a master's degree.

AGRICULTURAL BUSINESS COURSES

AGB 614 International Agricultural Trade. 3(2-2), D. Recommended Prerequisite: AGB 334 or MKT 350. Gains from trade, agricultural trade policies of exporters and importers, exchange rates, multilateral trade negotiations, preferential trade agreements, technical barriers and environmental regulations and trade. May be taught concurrently with AGB 514. Cannot receive credit for both AGB 514 and AGB 614.

AGB 624 Agricultural Prices. 3(2-2), F,S. Recommended Prerequisite: AGB 334. Factors influencing the level and movement of agricultural commodity prices and prices of agricultural inputs. May be taught concurrently with AGB 524. Cannot receive credit for both AGB 524 and AGB 624.

AGB 684 Farm Business Management. 3(2-2), F,S. Recommended Prerequisite: AGB 144. Economic principles applied to the organization and operation of agricultural units; tools of decision-making; and factor allocation. May be taught concurrently with AGB 584. Cannot receive credit for both AGB 584 and AGB 684.

AGRICULTURAL EDUCATION COURSES

AGE 608 Teaching Adults in Vocational Education. 3(3-0), D. Prerequisite: permission of instructor. Rise of the adult education movement; learning abilities, educational interests and vocational needs of adults; problems and procedures in organizing and operating adult education programs; relationship of adult education to public school education. Identical with AGV 627 and SEC 627. Cannot receive credit for AGV 627 and SEC 627 and AGE 608. May be taught concurrently with AGE 508. Cannot receive credit for both AGE 508 and AGE 608.

AGE 628 Agriculture Education-Special Topics. 1-3 D. Prerequisite: permission of instructor. Special study of agricultural education topics not covered in other courses. Course may be repeated to a total of 5 hours provided the same topic is not duplicated. May be taught concurrently with AGE 518. Cannot receive credit for both AGE 628 and AGE 518.

AGE 648 Agriculture in the Classroom. 1(1-0), Su. Course is designed to help elementary teachers better appreciate the importance of agriculture in their student's lives and to better understand Missouri agriculture. Course stresses integration of resources available from the agricultural industry across the curriculum. May be taught concurrently with AGE 548. Cannot receive credit for both AGE 548 and AGE 648.

AGE 658 Teaching of Agriculture. 3(3-0), S. Prerequisite: SEC 302 and EDC 350 and teacher certification students must be admitted to the teacher education program. Establishing objectives and organizing the course, selecting textbooks and equipment, securing and using teaching aids; using workbooks and notebooks, planning field trips, selecting and supervising projects. Credited only on B.S. in Education (Secondary). A grade of "C" or better is required in this course in order to take AGE 493 or AGE 494. May be taught concurrently with AGE 558. Cannot receive credit for both AGE 558 and AGE 658.

AGE 668 Course and Program Building in Agricultural Education. 3(3-0), S. Prerequisite: AGE 318 and AGE 658. Organization and analysis of agricultural instruction courses and programs; including the adoption of resource materials to meet individual student needs. May be taught concurrently with AGE 568. Cannot receive credit for both AGE 568 and AGE 668.

AGE 678 Methods of Teaching Agricultural Management. 2(2-0), S. Prerequisite: AGE 318 and AGE 658. Identification, development, and utilization of supervised agriculture experience programs in Agricultural Education that includes methods of teaching program management, record keeping, and appropriate methodologies. May be taught concurrently with AGE 578. Cannot receive credit for both AGE 578 and AGE 678.

AGE 688 Methods of Teaching Agricultural Laboratory Management. 2(1-2), S. Prerequisite: AGE 318 and AGE 658. Prepare prospective agricultural science teachers to determine subject matter, methods of teaching, and organization of equipment and facilities as applied to agricultural laboratories in high schools. May be taught concurrently with AGE 588. Cannot receive credit for both AGE 588 and AGE 688.

AGE 718 Topics in Agricultural Education. 1-3, D. Prerequisite: permission of instructor. Current developments and trends in teaching agricultural education as well as new developments in resources and techniques. May be repeated, however, only 9 hours will count towards the graduate program of study.

AGE 728 Induction Year Teaching I. 2(2-0), F,S. Prerequisite: permission of instructor. Course for the professional development of first-year teachers of agriculture. The course focuses on the pedagogical knowledge, skills, and attitudes and managerial skills needed by beginning teachers of agriculture.

AGE 738 Induction Year Teaching II. 2(2-0), F,S. Prerequisite: AGE 728. Course for the professional development of second-year teachers of agriculture. The course is a continuation of AGE 728 and focuses on the pedagogical knowledge, skills, and attitudes and managerial skills needed by beginning teachers of agriculture.

AGRICULTURAL TECHNOLOGY COURSES

AGT 621 Selection and Organization of Industrial Education. 3(3-0), F. Prerequisite: AGT 416 or concurrent enrollment; and AGT 420 or concurrent enrollment. Selection and arrangement of units to teach; preparation of informational and job assignments; selection, purchase and arrangement of laboratory equipment; dispensing of supplies and keeping of adequate records. Course typically taught in same semester as AGT 416 and AGT 420. Identical with AGV 621. Cannot receive credit for both AGT 621 and AGV 621. May be taught concurrently with AGT 521. Cannot receive credit for both AGT 521 and AGT 621.

AGRICULTURAL VOCATIONAL COURSES

AGV 620 Occupational Analysis. 1-2, D. Analysis and breakdown of broad occupations or specific jobs into basic elements for instructional purposes. Identical with BSE 620. May be repeated to a total of 2 hours when topic varies. May be taught concurrently with AGV 520. Cannot receive credit for both AGV 520 and AGV 620.

AGV 621 Selection and Organization of Industrial Education. 3(3-0), D. Selection and arrangement of units to teach; preparation of informational and job assignments; selection, purchase and arrangement of laboratory equipment; dispensing of supplies and keeping of adequate records. Course typically taken in same semester as AGT 416. Identical with AGT 621. Cannot receive credit for both AGV 621 and AGT 621. May be taught concurrently with AGV 521. Cannot receive credit for both AGV 521 and AGV 621.

AGV 622 Philosophy of Vocational Education. 1-3, D. Philosophical foundations of vocational education; philosophies of vocational education in the contemporary school. Identical with SEC 622 and BSE 622. May be repeated to a maximum of 3 credit hours when topic varies. May be taught concurrently with AGV 522. Cannot receive credit for both AGV 522 and AGV 622.

AGV 623 Guidance for Vocational Development. 1-3, D. Materials, procedures, and problems involved in the guidance of individuals in the selection of, preparation for, and advancement in a vocation. Identical with BSE 623. May be repeated to a total of 3 hours when topics varies. May be taught concurrently with AGV 523. Cannot receive credit for both AGV 523 and AGV 623.

AGV 625 Organization and Management in Vocational Education. 3(3-0), D. A systematic approach to defining and measuring occupational knowledge, skills and attitudes based upon an occupational analysis, instructional methodology, evaluation, and program standards. May be taught concurrently with AGV 525. Cannot receive credit for both AGV 525 and AGV 625.

AGV 626 Coordination of Cooperative Education. 1-2 D. Problems and procedures in organizing and operating part-time cooperative and evening occupation programs. Identical with BSE 626 and SEC 626. May be repeated to a total of 2 hours when topic varies. May be taught concurrently with AGV 526. Cannot receive credit for both AGV 626 and AGV 526.

AGV 627 Teaching Adults in Vocational Education. 3(3-0), D. Rise of the adult education movement, learning abilities, educational interests, and vocational needs of adults; problems and procedures in organizing and operating adult education programs; relationship of adult education to public school education. Identical with AGE 608 and SEC 627. Cannot receive credit for AGV 627 and AGE 608 and SEC 627. May be taught concurrently with AGV 527. Cannot receive credit for both AGV 527 and AGV 627.

AGV 628 Measurement and Evaluation of Vocational Education Programs. 1-3, D. Means for assessing specific program needs as determined from occupational surveys and other demographic data; follow-up techniques to evaluate the overall effectiveness of the program to the manpower needs in a given labor market area. Identical with BSE 628 and SEC 628. May be repeated to a total of 3 hours with departmental approval when topic varies. May be taught concurrently with AGV 528. Cannot receive credit for both AGV 528 and AGV 628.

AGV 676 Teaching of Industrial/Vocational Subjects. 3(3-0), D. Instructional methods and techniques of teaching industrial/vocational education subjects; attaining objectives of career and technical education, design and evaluation of instructional units; classroom and laboratory management; and development of evaluative instruments. May be taught concurrently with AGV 576. Cannot receive credit for both AGV 576 and AGV 676.

AGV 724 Organization and Administration of Vocational Education. 1-3, D. Prerequisite: permission of instructor. Problems, procedures and local, state and federal relationships in the organization and administration of vocational education in the contemporary school. Identical with SFR 724. May be repeated to a total of 3 hours when topic varies.

AGV 726 Seminar in Industrial Education. 3(3-0), D. Prerequisite: permission of instructor. Presentation and discussion of professional or technical problems in the organization and management of programs and facilities in industrial education.

AGV 760 Special Investigations. 1-5, D. Prerequisite: permission of instructor. The student, in consultation with the advisor, selects for in-depth study an area determined by the interest/career objectives of the student. Based on demand and timeliness of the subject, a cluster study group may engage in a joint investigation.

AGRONOMY COURSES

AGA 605 Advanced Soil Fertility. 3(2-2), D. Recommended Prerequisite: AGA 405. Theoretical and Applied aspects of soil fertility emphasizing ion transport, nutrient availability, and root absorption in soils-plant environments. May be taught concurrently with AGA 505. Cannot receive credit for both AGA 505 and AGA 605.

AGA 645 Soil Survey and Land Appraisal. 3(2-2), F. Recommended Prerequisite: 6 hours in soils. Soil as a natural body, its morphological and chemical properties, and methods used to distinguish among different soils; description and identification of soil profiles; techniques in soil mapping; and interpretation of soil survey data. May be taught concurrently with AGA 545. Cannot receive credit for both AGA 545 and AGA 645.

AGA 655 Soil Genesis, Morphology, and Classification II. 3(2-2), D. Recommended Prerequisite: AGA 345 and AGA 455. Pedogenetic processes, macromorphology, micromorphology, redoximorphic features, and classification as related to soil taxonomy. May be taught concurrently with AGA 555. Cannot receive credit for both AGA 555 and AGA 655.

AGA 675 Plant Improvement. 3(2-3), D. Recommended Prerequisite: AGA 105. Application of genetic principles to the improvement of crop plants. Includes self-pollinated, cross-pollinated, and asexually-propagated crops. May be taught concurrently with AGA 575. Cannot receive credit for both AGA 575 and AGA 675. 2(2-0), S

AGA 725 Advanced Soils Interpretations. 3(2-3) D. Recommended Prerequisite: AGA 345 and AGA 455. Field interpretation of physical and chemical properties, water relationships, and soil landscape relationships.

ANIMAL SCIENCE COURSES

AGS 611 Animal Nutrition and Metabolism. 3(3-0), S. Recommended Prerequisite: AGR 300 or CHM 200 or CHM 310. Utilization and metabolism of nutrients by domestic animals; role of vitamins and minerals. May be taught concurrently with AGS 511. Cannot receive credit for both AGS 511 and AGS 611.

AGS 712 Special Topics in Animal Science. 1-3, D. Prerequisite: permission of instructor. Special study in an identified area of animal science not treated in other courses. Recent advances and new research techniques will be discussed. May be repeated when topic varies up to 6 hours.

AGS 716 Mammalian Reproductive Physiology. 3(3-0), S. Recommended Prerequisite: AGS 302. Comparative anatomy and physiological processes of reproduction with an emphasis on domestic and laboratory animals. Fertilization through embryonic development, pregnancy, and growth to sexual maturity, reproductive efficiency and application of reproductive technology.

ENTOMOLOGY/FORESTRY COURSES

AGW 613 Insects Affecting Horticultural and Forestry Crops. 3(1-4), F. Prerequisite: permission of instructor. Identification, life histories and control methods of insects affecting gardens, ornamental plants, orchards and forests. May be taught concurrently with AGW 513. Cannot receive credit for both AGW 513 and AGW 613.

FRUIT SCIENCE COURSES

AGF 700 Plant Science Colloquium. 1(1-0), F,S,Su. Prerequisite: permission of graduate coordinator. A series of oral presentations on new developments in plant science. Presentations to be made by faculty members, students, and guest speakers from industry and academe. May be repeated, but not more than 2 hours may be counted toward the M.S. Degree.

AGF 701 Advanced Pomology. 3(3-0), S. Prerequisite: permission of instructor. The culture and management of perennial fruit crops adapted to temperate climates. Physiology, technology, and research as it applies to modern production practices will be emphasized. May be taught concurrently with AGF 401. Students cannot receive credit for both AGF 401 and AGF 701.

AGF 711 Vitaculture. 3(3-0), S. Recommended Prerequisite: BIO 644. Principles of growing grapes based upon the genetics, physiology, development and morphology of the genus Vitis; the environments in which grapes are grown; and the uses of grapes. May be taught concurrently with FRS 411. Students cannot receive credit for both FRS 411 and FRS 711.

AGF 721 Enology. 3(3-0), S. Recommended Prerequisite: BIO 310. The course will study the chemistry, microbiology, and technology of modern wine production.

AGF 722 Enology Lab. 2(0-4), F. Prerequisite: AGF 721. Laboratory techniques in assessing wine production methods and quality.

AGF 730 Advanced Topics in Plant Science. 3(3-0), F. Prerequisite: permission of instructor. An advanced topic in plant science will be addressed via faculty lectures and student projects. Examples of proposed topics include: Improved Disease Resistance in Viticulture, Application of Field Collected Data to Computer Analysis. Identical with AGH 730. Variable content course. May be repeated to a total of 6 hours with differing topics.

AGF 731 Plant Genetic Engineering. 3(3-0), S. Prerequisite: permission of instructor. Principles, methodology, and commercial applications of plant biotechnology. Includes brief introduction to nucleic acid structure, gene regulation, and genome organization in eukaryotic and prokaryotic organisms.

AGF 798 Research. 1-6, F,S,Su. Prerequisite: permission of instructor. Supervised research in areas of emphasis within the discipline of plant science. May be repeated, but not more than 6 hours may be counted toward the M.S. degree.

AGF 799 Thesis. 1-6, F,S,Su. Prerequisite: permission of instructor. Demonstration of the capacity for research and independent thought culminating in a thesis. May be repeated, but no more than 6 hours will be applied to the master's degree.

HORTICULTURE/PLANT SCIENCE COURSES

AGH 643 Plant Propagation. 3(2-2) F. Recommended Prerequisite: either AGA 105 or BIO 121; and either CHM 105 or CHM 160. Practices employed by fruit and ornamental plant producers in propagation of plants, including seeds, cuttings, layerings, grafting and micropropagation. Supplemental course fee. May be taught concurrently with AGH 573. Cannot receive credit for both AGH 643 and AGH 573.

AGH 730 Advanced Topics in Plant Science. 3(3-0), F. Prerequisite: permission of instructor. An advanced topic in plant science will be addressed via faculty lectures and student projects. Examples of proposed topics include: Improved Disease Resistance in Viticulture, and Application of Field Collected Data to Computer Analysis. Variable content course. Identical with AGF 730. May be repeated to a total of 6 hours with differing topics.

AGH 753 Plant Stress Physiology. 3(3-0), D. Prerequisite: permission of instructor. The effects of environmental stresses on plant physiological functions and plant growth, plus cultural methods to help plants adapt to stress.

AGH 773 Plant Growth Regulation. 3(3-0), D. Prerequisite: permission of instructor. The role of natural and synthetic plant hormones and related compounds in the growth, reproduction and cultivation of plants.

MISSOURI STATE UNIVERSITY

DEPARTMENT OF BIOLOGY

S. Alicia Mathis, Department Head
Temple Hall, Room 212; Phone (417) 836-512
Fax (417) 836-4204; biology@missouristate.edu
http://biology.missouristate.edu

GRADUATE FACULTY

Professor: M. Christopher Barnhart, Daniel W. Beckman, Paul L. Durham, Frank A. Einhellig, Janice S. Greene, John E. Havel, John S. Heywood, Laszlo G. Kovacs, S. Alicia Mathis, Don L. Moll, Lynn W. Robbins, John G. Steiert, Thomas E. Tomasi, D. Alexander Wait
Associate Professor: Brian D. Greene, Georgianna Saunders
Assistant Professor: Kyoungtae Kim, Brian Weaver
Adjunct Faculty: Wendy B. Anderson**,** David E. Bowles, Sami Khoshyomn, Hsiu-ping Liu, Lloyd W. Morrison, Gareth A. Rowell
Emeritus Professor: Jerry D. Berlin, Loren L. Denney, Roar L. Irgens, Steven L. Jensen, Richard L. Myers, Grant L. Pyrah, Paul L. Redfearn, Russell G. Rhodes, Robert F. Wilkinson, Jr.

MASTER OF SCIENCE, BIOLOGY

D. Alexander Wait, Graduate Director
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PROGRAM DESCRIPTION

The Department of Biology offers a Master of Science in Biology, participates in the Master of Natural and Applied Science (MNAS) and the Master of Science in Plant Science, and in conjunction with the College of Education, the Master of Science in Education with emphases in biology and natural science. Together with an advisor, students design an individual program of study, selecting courses that provide additional background in biology as well as developing an area of concentration.

Areas of research include animal behavior, aquatic biology, cellular biology, ecology, field biology, immunology, microbiology, physiology, systematics, and wildlife conservation. During the first semester, the student declares an area of specialization and begins to pursue a research problem (thesis) with the close supervision of a graduate faculty thesis committee.

Most course work is usually completed by the end of the second or third semester, and the thesis or non-thesis option is completed after four or five semesters. A comprehensive examination is taken during the second year. A maximum of 9 hours of approved graduate courses taken in related subjects outside the Biology department may be counted.

This graduate program has been designed to provide opportunities for continued study and mastery of new skills for those who desire to maintain or increase their competence in biology and its allied environmental and healthrelated fields. Some students completing the program have continued their education in doctoral programs, while others have accepted positions as conservationists, ecologists, industrial laboratory supervisors, research assistants, or teachers in secondary schools or colleges.

ENTRANCE REQUIREMENTS

1. The student must have a minimum of 24 undergraduate hours (or equivalent) in biology. In the case of a student whose preparation for formal graduate study is judged to be inadequate (including cognate areas such as chemistry, physics, or mathematics), a program of prerequisite course work may be outlined for the purpose of properly supplementing his/her preparation. Such courses will not be credited as course requirements for the degree.
2. Candidates for admission to programs in biology are required to have a GPA of at least 2.75 (on a 4.00 scale) for the last 60 semester hours of undergraduate work and a 3.00 average in biology.
3. Scores from the Graduate Record Examination (GRE), General Test must be submitted.
4. A statement of interest and three letters of reference are required for admission to the degree program.

ACCELERATED MASTERS DEGREE OPTION

Eligible Missouri State University undergraduate majors in biology may apply for preliminary acceptance into the Master of Science program in Biology after admission requirements for the accelerated masters option have been satisfied. {Note: biology majors at other universities approved for participation in this program may apply if they meet the requirements below.} If accepted, undergraduate courses chosen from approved 600 or 700-level courses may be counted toward both the undergraduate and graduate degrees, with a maximum of 12 credit hours counted. This option offers an opportunity for biology majors with undergraduate laboratory research experience to complete the course requirements for the Master of Science degree in Biology in two semesters and a summer after attaining the Bachelor's degree, rather than the typical four semesters and a summer. Contact the Department of Biology for further information and guidelines.

Before enrolling in a course to be counted as both undergraduate and graduate credit and to count the courses toward the masters degree, an undergraduate student must be accepted into the accelerated program and complete a mixed credit form. Acceptance into the program and all approvals must be completed prior to the end of the Change of Schedule Period for the course(s). See the "Graduate College" section for further information.

ADMISSION REQUIREMENTS FOR THE ACCLEREATED MASTER'S OPTION

1. Junior standing, a GPA in biology of 3.25 or better and an overall GPA of 3.25 or better.
2. Completion of BIO 121, 122, 235, 369, 310 or 320 or 361; CHM 200 or 310; MTH 138 or 135 and 181 with an overall GPA of 3.25 or better.
3. Undergraduate laboratory or field research experience in residence in the Department of Biology with a supportive recommendation from the student's undergraduate research advisor. [Note: undergraduate research experience at another university conducted in collaboration with Missouri State University Biology faculty may be considered.]
4. GRE scores commensurate with the advanced standing of this option.
5. Acceptance of applicant by a graduate faculty member who agrees to serve as the student's graduate research advisor.
6. Acceptance of the applicant by the graduate faculty in Biology under the accelerated masters option.

GRADUATE ASSISTANTSHIPS

Evaluation of applications for teaching assistantships begins on March 1 (fall assistantships) and October 1 (spring assistantships), and will continue until positions are filled. Applicants must first be accepted into the program, and files must be complete to be considered. Therefore, applicants should apply by February 1/September 1 to ensure being considered for a TA position.

RETENTION REQUIREMENTS

To remain in the program, a student must maintain a GPA of 3.00 and make satisfactory progress on the research project.

DEGREE REQUIREMENTS **Total 32 hrs**

1. **Program of Study**. The program for each candidate will be structured by the candidate's committee in consultation with the student, and must include at least 32 semester hours of graduate credit. Evaluation of previous training and academic objectives will be important factors in establishing this program.
2. **Biology Requirement** (minimum 23 semester hours). A minimum of 16 hours of biology from courses numbered 700799 inclusive.
3. **Electives** (maximum 9 semester hours). Approved graduate courses may be selected from related fields to a maximum of 9 hours. Any deviation from this maximum will require approval by department head.
4. **Research.** For both options, the student is required to give an oral presentation of his/her work to the Department.
   Thesis Option: Completion of a satisfactory thesis in the candidate's discipline (maximum of 6 hours of BIO 798 and 6 hours of BIO 799).
   Non-thesis Option: After an unsuccessful attempt at a thesis, and with the permission of the thesis committee and department head, a student may switch to a non-thesis option. This requires the completion of a minimum of two degree papers, each of which shall require an extensive paper or major creative work. Four hours of BIO 790 and four hours of BIO 798 may be counted toward this degree under this option.
5. **Comprehensive Examination.** Both a written and an oral comprehensive examination must be passed by the candidate before a degree will be granted. The written examination is taken after most of the course work has been completed, and is written and evaluated by the student's thesis committee. The examination can include comprehensive questions in biology and questions specific to the area of study chosen by the student. The use of computers is encouraged, where appropriate, for the written examination. The oral examination follows the presentation of the student's thesis research or degree paper to the faculty. The examination tests the student's understanding of the research or degree paper.

MASTER OF SCIENCE, PLANT SCIENCE

(See "Department of Agriculture")

MASTER OF NATURAL AND APPLIED SCIENCE

This is an interdisciplinary program within the College of Natural and Applied Science. Accelerated master's program available. (See "Master of Natural and Applied Science").

MASTER OF SCIENCE IN EDUCATION, SECONDARY EDUCATION: BIOLOGY AREA OF EMPHASIS

Contact Dr. Georgianna Saunders or Dr. Janice Greene and see requirements for the M.S.Ed., Secondary Education under Interdisciplinary Graduate Programs, page 61.

BIOLOGY REQUIREMENTS

Biology courses including a minimum of 3 hrs in courses numbered 700 or above **Total 15 hrs**

MASTER OF SCIENCE IN EDUCATION, SECONDARY EDUCATION: NATURAL SCIENCE AREA OF EMPHASIS

Contact Dr. Tamera Jahnke and see program requirements for the M.S.Ed., Secondary Education under Interdisciplinary Graduate Programs, page 61.

NATURAL SCIENCE PREREQUISITE AND REQUIREMENTS

In this option, students complete a minimum of 15 hours with course work selected from two of the following disciplines: Biology, Chemistry, Geography and/or Geology, Mathematics, and Physics. A minimum of 3 hours of course work numbered 700 or above must be included. The prerequisite requirements are those listed in the departmental statements of both selected academic areas of emphasis.

Courses from one of the above disciplines 9 hrs
Courses from a second of the above disciplines 6 hrs
Total 15 hrs

ADDITIONAL OPPORTUNITIES

In addition to working in the department, a student may take courses or do research at the Gulf Coast Research Laboratory, Ocean Springs, Mississippi or the State Fruit Experiment Station, Mountain Grove, Missouri. Also, the University operates the Bull Shoals Field Station in Taney County, Missouri.

BIOLOGY COURSES

BIO 608 Environmental Microbiology. 3(2-2), F. Recommended Prerequisite: microbiology. The study of the ecology of microorganisms and the applied use of microorganisms by man in the environment. Laboratory will emphasize current methods used in the field of environmental microbiology. May be taught concurrently with BIO 508. Cannot receive credit for both BIO 508 and BIO 608.

BIO 609 Stream Ecology. 4(2-4), S. Recommended Prerequisite: ecology course and one year of college chemistry. The interdisciplinary study of running waters, including study of the physical and chemical environment, trophic interactions, nutrient cycling, and the multiple impacts of humans on modifying these systems. Lectures, group discussion of readings, and laboratory and field exercises. One all-day Saturday field trip required. May be taught concurrently with BIO 509. Cannot receive credit for both BIO 509 and BIO 609.

BIO 611 Immunology. 3(2-2), F,S. Recommended Prerequisite: microbiology course. Fundamental principles of immunology. Lecture emphasis on the structure and function of antigens, antibodies, surface receptors, antigen-antibody interactions, other serologic reactions, immunoglobulin formation, cell responses, major histocompatibility complex, immunochemistry, immunogenetics, autoimmunity, immunosuppression, transplantation immunology and immunologic methods. Laboratory emphasis on immunologic techniques for investigative as well as clinical application. Supplemental course fee. May be taught concurrently with BIO 511. Cannot receive credit for both BIO 511 and BIO 611.

BIO 613 Industrial Microbiology. 3(2-2), D. Recommended Prerequisite: microbiology course. An introduction to the fundamental concepts of industrial and applied microbiology. The industrial production of proteins, metabolites, polymers, biocides, and vaccines will be discussed in addition to biotransformations and environmental applications. Production improvement strategies that employ both physical and modern molecular techniques will be introduced. Laboratory will emphasize the selection of industrially important microorganisms, the theory and operation of a fermentor for the production of proteins, antibiotics, and steroids, use of analytical equipment for monitoring product formation, enzymes analysis, downstream processing, and bio-reactor construction and design. May be taught concurrently with BIO 512. Cannot receive credit for both BIO 512 and BIO 613.

BIO 616 Evolution. 3(3-0), F,S. Recommended Prerequisite: genetics course; and college algebra or pre-calculus mathematics course. A survey of modern evolutionary biology, including the evidence that supports the theory of evolution, the natural processes that cause evolution, patterns and mechanisms of speciation, and methods for estimating evolutionary relationships. May be taught concurrently with BIO 515. Cannot receive credit for both BIO 515 and BIO 616.

BIO 617 Microbial Physiology and Metabolism. 4(2-4), F. Recommended Prerequisite: microbiology course and organic chemistry course. Physiology and anatomy of microorganisms including adaptive responses to environmental changes and microbial metabolic diversity will be discussed. Laboratory will emphasize selective isolation and identification of microorganisms, the growth dynamics of microorganisms, and responses by microorganisms to environmental changes. May be taught concurrently with BIO 517. Cannot receive credit for both BIO 517 and BIO 617.

BIO 620 Pathogenic Microbiology. 3(3-0), S. Recommended Prerequisite: microbiology course. Fundamental principles of pathogenic microbiology; transmission, infection and control of the pathogen. May be taught concurrently with BIO 520. Cannot receive credit for both BIO 520 and BIO 620.

BIO 621 Marine Science for Teachers I. 2(2-0) Su. Prerequisite: 12 hours in biology. Recommended Prerequisite: genetics course. A course designed to introduce students, particularly inservice teachers, to the study of marine science and to promote the teaching of marine biology at all grade levels. May be taught concurrently with BIO 521. Cannot receive credit for both BIO 521 and BIO 621.

BIO 623 Marine Science for Teachers I Lab. 1(0-2), Su. Prerequisite: concurrent enrollment in BIO 621. Laboratory portion of BIO 621. May be taught concurrently with BIO 522. Cannot receive credit for both BIO 522 and BIO 623.

BIO 627 Field Biology. 1-4, D. Prerequisite: permission of instructor. Field work during an extended field trip to a specific region of North America to familiarize the student with the flora and/or fauna of that region. Course is scheduled irregularly during academic breaks and may be preceded by several lectures in preparation for the trip. May be repeated to a total of 6 credits with a maximum of 3 credits to be applied to the major in biology. Supplemental course fee (variable by section). May be taught concurrently with BIO 527. Cannot receive credit for both BIO 527 and BIO 627.

BIO 629 Phycology. 3(2-2), S. Recommended Prerequisite: ecology course. The structure, function, ecological significance, and diversity of algae. Emphasis will be placed on field studies, isolation and growth, and physiological characteristics. May be taught concurrently with BIO 530. Cannot receive credit for both BIO 530 and BIO 629.

BIO 631 Economic Botany. 2(2-0), FE. Recommended Prerequisite: introductory biology course with lab. Distribution and origin of plants which yield food, poison, drugs, spices, fibers, oils and other products generally used by man. Methods of preparations and analysis of products and ingredients. May be taught concurrently with BIO 531. Cannot receive credit for both BIO 531 and BIO 631.

BIO 632 Principles of Fisheries Management. 3(2-2), S. Recommended Prerequisite: ecology or wildlife management course. Life history, population ecology, and management of exploited freshwater and marine species. Scientific sampling and analysis of fishery populations. Characterization, history, and management principles for representative commercial and recreational fisheries. May be taught concurrently with BIO 532. Cannot receive credit for both BIO 532 and BIO 632.

BIO 633 Wetland Ecology. 3(2-2), F. Recommended Prerequisite: ecology course; and one year of college chemistry. The composition, structure, function, and importance of wetland ecosystems. Comparisons of different wetland types, hydrology, nutrient cycles, plants and animals and their adaptations, and conservation strategies. May be taught concurrently with BIO 533. Cannot receive credit for both BIO 533 and BIO 633.

BIO 635 Coastal Vegetation Lab. 1(0-2), Su. Prerequisite: concurrent enrollment in BIO 641. Laboratory portion of BIO 641. May be taught concurrently with BIO 535. Cannot receive credit for both BIO 535 and BIO 635.

BIO 636 Plant Ecology. 4(2-4), F. Recommended Prerequisite: ecology course. The dynamics, structure, and distribution of plant populations and communities, with emphasis on interactions among plants, plants and other organisms, and plants and ecosystems. Laboratory emphasis on experimental studies in the greenhouse and field. Weekend field trip is required. BIO 436 may be taught concurrently with BIO 636. Cannot receive credit for both BIO 436 and BIO 636.

BIO 637 Salt Marsh Plant Ecology Lab. 2(2-0), Su. Prerequisite: permission of advisor or department head. Recommended Prerequisite: general biology II, plant taxonomy, ecology and plant physiology course. A study with emphasis on the botanical aspects of local marshes; includes plant identification, composition, structure, distribution, and development of coastal marshes. Biological and physical interrelationships. Primary productivity and relation of marshes to estuaries and associated fauna. May be taught concurrently with BIO 537. Cannot receive credit for both BIO 537 and BIO 637.

BIO 638 Salt Marsh Ecology Lab. 2(0-4), Su. Prerequisite: concurrent enrollment in BIO 637. Laboratory portion of BIO 637. May be taught concurrently with BIO 538. Cannot receive credit for both BIO 538 and BIO 638.

BIO 639 Biogeography. 2(2-0), F. Recommended Prerequisite: general biology I and II courses. Study of patterns of distribution of organisms in space and in time. May be taught concurrently with BIO 539. Cannot receive credit for both BIO 539 and BIO 639.

BIO 640 App of Molecular Markers. 4(2-4), D. Prerequisite: permission. Recommended Prerequisite: genetics course. Introduction to the use of molecular markers in biological research. Topics covered include methods for identifying genetic variation at the molecular level (protein electrophoresis, automatic DNA sequencing, RAPDs, RFLPs, AFLPs, microsatellites) and their applications to research in systematics, ecology, evolution, conservation biology, forensics, and gene mapping. Students will complete research projects using one or more of the techniques learned. Supplemental course fee. May be taught concurrently with BIO 540. Cannot receive credit for both BIO 540 and BIO 640.

BIO 641 Coastal Vegetation. 2(2-0), Su. Prerequisite: 10 hours of biology and permission of advisor or department head. Recommended Prerequisite: general biology I and II courses. A broad study of the general and specific aspects of coastal vegetation, with emphasis on local examples. Vegetational composition, variation, succession, climax, and distribution. Includes aerial techniques, plant identification, delineation of vegetational types and mapping. May be taught concurrently with BIO 534. Cannot receive credit for both BIO 534 and BIO 641.

BIO 644 Plant Physiology. 4(3-2), D. Recommended Prerequisite: organic chemistry course. Basic chemical and physical principles of plant function considering water relationships, nutrient transport, mineral nutrition, photosynthesis, respiration, and phytohormones. May be taught concurrently with BIO 544. Cannot receive credit for both BIO 544 and BIO 644.

BIO 645 Agrostology. 2(1-2), FO. Recommended Prerequisite: plant taxonomy course. Identification of local, native and economically important grasses. May be taught concurrently with BIO 545. Cannot receive credit for both BIO 545 and BIO 645.

BIO 646 Plant Morphology. 4(2-4), D. Recommended Prerequisite: general biology I and II courses. A study of the form, structure, and evolution of plants. May be taught concurrently with BIO 546. Cannot receive credit for both BIO 546 and BIO 646.

BIO 650 Statistical Methods for Biologists. 3(3-0), F,S. Recommended Prerequisite: genetics course and pre-calculus mathematics course. Scientific methodology, experimental design, statistical analysis, and data interpretation applied to biological questions. May be taught concurrently with BIO 550. Cannot receive credit for both BIO 550 and BIO 650.

BIO 651 Advanced Statistical Methods for Biologists. 2(1-2), D. Recommended Prerequisite: statistics course. The design and analysis of biological experiments, with an emphasis on the choice and interpretation of inferential statistics. Topics covered include causal inference, statistical power, general linear models, repeated measures designs, log-linear models, nonparametric procedures, and computer-intensive techniques. The use of computer software to analyze real data sets from the biological literature is emphasized. May be taught concurrently with BIO 551. Cannot receive credit for both BIO 551 and BIO 651.

BIO 654 Marine Ichthyology. 3(3-0), Su. Prerequisite: 16 hours of biology and permission of advisor or department head. Recommended Prerequisite: General Biology I and II, Genetics and Comparative Vertebrate Anatomy. This course provides the student with a strong general background in the biology of marine fishes. Emphasis placed on the principles involved in the classification and taxonomy of marine and estuarine fishes. May be taught concurrently with BIO 555. Cannot receive credit for both BIO 555 and BIO 654.

BIO 656 Marine Ichthyology Lab. 3(0-6), Su. Prerequisite: concurrent enrollment in BIO 654. Laboratory portion of BIO 654. May be taught concurrently with BIO 556. Cannot receive credit for both BIO 556 and BIO 656.

BIO 657 Marine Fisheries Management. 2(2-0), Su. Prerequisite: permission of instructor; and concurrent enrollment in BIO 658. A course designed to familiarize students with practical marine fisheries management problems in today's real world. Covers the international and local, economic, social, legal, and political, as well as biological factors that are considered in decisions directed toward achieving optimum sustainable yield from marine resources. The history of management schemes, sources of information, current status of fishing technology, management methods, legal problems and educational needs are explored. May be taught concurrently with BIO 557. Cannot receive credit for both BIO 557 and BIO 657.

BIO 658 Marine Fisheries Management Lab. 2(0-4), Su. Prerequisite: concurrent enrollment in BIO 657. Laboratory portion of BIO 657. May be taught concurrently with BIO 558. Cannot receive credit for both BIO 558 and BIO 658.

BIO 659 Population Genetics and Evolutionary Mechanisms. 3(3-0), D. Recommended Prerequisite: evolution course and statistics course. The theory of genetic variation in populations, with emphasis on quantitative description of the mechanisms of biological evolution. May be taught concurrently with BIO 560. Cannot receive credit for both BIO 560 and BIO 659.

BIO 662 Limnology. 4(2-4), F. Recommended Prerequisite: ecology course; and one year of college chemistry. Physical, chemical, and biological characteristics of lakes and reservoirs. Laboratory includes mapping, lake models, water chemistry, and surveys of diversity and abundance. Two all-day Saturday labs required. May be taught concurrently with BIO 562. Cannot receive credit for both BIO 562 and BIO 662.

BIO 663 Population Ecology. 3(2-2), S. Recommended Prerequisite: ecology course and pre-calculus mathematics course. Discussion of factors controlling the distribution and abundance of populations. Quantitative description of population dynamics is emphasized. May be taught concurrently with BIO 563. Cannot receive credit for both BIO 563 and BIO 663.

BIO 665 Marine Ecology. 3(3-0), Su. Prerequisite: 16 hours of biology and permission of advisor or department head. Recommended Prerequisite: General Biology I and II. A consideration of the relationship of marine organisms to their environment includes the effects of temperature, salinity, light, nutrient concentration, currents, and food on the abundance and distribution of marine organisms. Concurrent enrollment in BIO 566 required. May be taught concurrently with BIO 565. Cannot receive credit for both BIO 565 and BIO 665.

BIO 666 Marine Ecology Lab. 2(0-4), Su. Prerequisite: concurrent enrollment in BIO 665. Laboratory portion of BIO 665. May be taught concurrently with BIO 566. Cannot receive credit for both BIO 566 and BIO 666.

BIO 668 Physiological Ecology. 4(4-0), SE. Recommended Prerequisite: ecology course; and general physiology or plant physiology or human physiology course. Physiological adaptations of plants and animals to environmentally stressful conditions and to ecological/evolutionary pressures. May be taught concurrently with BIO 567. Cannot receive credit for both BIO 567 and BIO 668.

BIO 671 Comparative Animal Physiology. 4(3-3), SO. Recommended Prerequisite: general physiology or human physiology course. Organ/system function in a wide range of invertebrate and vertebrate animals. May be taught concurrently with BIO 571. Cannot receive credit for both BIO 571 and BIO 671.

BIO 673 Ornithology. 3(2-2), S. Prerequisite: 12 hours of biology. Taxonomy, distribution, life histories and ecology of birds; emphasis on Missouri forms. Early morning field trips required. May be taught concurrently with BIO 573. Cannot receive credit for both BIO 573 and BIO 673.

BIO 674 Aquatic Entomology. 2(1-3), D. Aquatic insects, ecology and taxonomy with emphasis on field applications. May be taught concurrently with BIO 574. Cannot receive credit for both BIO 574 and BIO 674.

BIO 675 Ichthyology. 3(2-2), F. Prerequisite: 12 hours in biology. Taxonomy, distribution, life histories and ecology of fish with emphasis on Missouri forms. May be taught concurrently with BIO 575. Cannot receive credit for both BIO 575 and BIO 675.

BIO 676 Herpetology. 3(2-2), S. Prerequisite: 12 hours in biology. Taxonomy, distribution, life histories and ecology of amphibians and reptiles with emphasis on Missouri forms. One weekend field trip required. May be taught concurrently with BIO 576. Cannot receive credit for both BIO 576 and BIO 676.

BIO 677 Mammalogy. 3(2-2), F. Prerequisite: 12 hours in biology. Taxonomy, distribution, life histories and ecology of mammals with emphasis on Missouri forms. One weekend field trip required. May be taught concurrently with BIO 577. Cannot receive credit for both BIO 577 and BIO 677.

BIO 678 Behavioral Ecology. 4(3-2), S. Recommended Prerequisite: ecology course and statistics course. Fundamental principles of animal behavior with an emphasis on the study of the ecological and evolutionary processes that influence behavior. May be taught concurrently with BIO 578. Cannot receive credit for both BIO 578 and BIO 678.

BIO 679 Conservation Biology. 4(3-2), D. Recommended Prerequisite: genetics course and ecology course. An in-depth examination of the science of conservation from a biological perspective, with an examination of ethical and legal aspects of conservation. May be taught concurrently with BIO 579. Cannot receive credit for both BIO 579 and BIO 679.

BIO 680 Vertebrate Anatomy and Evolution. 2(2-0), F,S. Vertebrate gross anatomy. Phylogeny and present status of organ systems in vertebrates. May be taught concurrently with BIO 380. Cannot receive credit for both BIO 380 and BIO 680.

BIO 685 Marine Conservation. 1-3, D. An overview of current issues related to the conservation and management of marine organisms, with emphasis on marine species and habitats exploited or endangered by human actions. BIO 485 may be taught concurrently with BIO 685. Cannot receive credit for both BIO 685 and 485.

BIO 686 Fish Ecology. 3(3-0), D. Recommended Prerequisite: ecology course and icthyology course. The biology of fishes in relation to environmental conditions at the individual, population, and community levels. May be taught concurrently with BIO 584. Cannot receive credit for both BIO 584 and BIO 686.

BIO 687 Marine Invertebrate Zoology. 3(3-0), Su. Prerequisite: 16 hours in biology; and concurrent enrollment in BIO 688. A concentrated study of the free-living marine and estuarine invertebrates of Mississippi Sound and adjacent bayous, salt marshes, barrier islands, and the nearshore continental shelf of the northeastern Gulf of Mexico. Course emphasizes structure, classification, phylogenetic relationships, larval development, functional processes, and ecological aspects of Gulf of Mexico invertebrates and their natural assemblages. Advanced undergraduates and graduate students may be asked to conduct independent, short-term research projects during the course. May be taught concurrently with BIO 587. Cannot receive credit for both BIO 587 and BIO 687.

BIO 688 Marine Invertebrate Zoo Lab. 3(0-6), Su. Prerequisite: concurrent enrollment in BIO 687. Laboratory portion of BIO 687. May be taught concurrently with BIO 588. Cannot receive credit for both BIO 588 and BIO 688.

BIO 689 Game Management. 3(3-0), D. Recommended Prerequisite: wildlife management course. Management of game birds and mammals for recreational utilization. May be taught concurrently with BIO 589. Cannot receive credit for both BIO 589 and BIO 689.

BIO 697 Topics in Biology. 1-4, D. Prerequisite: permission of instructor. A variable content course to provide for the offering of selected topics in biology on a one time or first-time basis. May be repeated for credit when topic varies. May be taught concurrently with BIO 597. Cannot receive credit for both BIO 597 and BIO 697.

BIO 710 Topics in Microbial Physiology. 3(3-0), S. Topics of interest in microbial physiology will be discussed. These may include, cell structure, energy production, fermentation, nitrogen metabolism, protein and nucleic acid syntheses, regulation of gene expression, and dynamics of cell growth. Lecture will supplement discussion sessions.

BIO 712 Advanced Immunology. 2(2-0), S. Recommended Prerequisite: immunology course. Cellular aspects of the immune system.

BIO 722 Regulatory Mechanisms in Microorganisms. 2(2-0), S. Regulation of macromolecular synthesis and enzyme activity in bacteria and viruses.

BIO 725 Advanced Limnology. 2(2-0), D. Recommended Prerequisite: limnology course. Advanced concepts of biological, chemical and physical limnology. Recent symposia, reviews, and primary literature are discussed. Prerequisite: BIO 562. Advanced concepts of biological, chemical and physical limnology. Recent symposia, reviews, and primary literature are discussed.

BIO 726 Advanced Limnology Methods. 2(0-4), D. Recommended Prerequisite: limnology course. Research and practical application of modern limnological methods are taught.

BIO 728 Recent Advances in Biology. 1(0-2), F,S. Prerequisite: permission of instructor. Selected topics in biology to be discussed using original literature as the focal point. Variable content course. May be repeated when topic varies.

BIO 730 Advanced Topics in Biology. 1-4, F,S. Prerequisite: permission of instructor. Individual study in biology; may include literature, field and/or laboratory work. May be repeated.

BIO 734 Advanced Plant Taxonomy. 4(2-4), D. Prerequisite: permission of instructor. Philosophy and principles of modern taxonomic procedures.

BIO 755 Advanced Developmental Biology. 4(3-2), S. Recommended Prerequisite: cell biology course. An in-depth study of the molecular and cellular mechanisms involved in the development of vertebrate, invertebrate, and plant systems. Lectures will emphasize fertilization, morphogenesis, differentiation, induction, regeneration, and neoplasia. Laboratory exercises will emphasize techniques utilized by developmental biologists. Review of current literature and poster presentations will be required. Cannot receive credit for both BIO 355 and BIO 755.

BIO 760 Topics in Teaching Biology. 1-3, D. Prerequisite: permission of instructor. Biological concepts, information, practical experiences, and use of resource materials in the elementary and secondary classroom. Variable content course. May be repeated when topic varies.

BIO 761 Environmental Science for Educators. 2(1-2), F. Prerequisite: permission of instructor. Discussion of environmental issues, practical experiences in teaching environmental concepts, and awareness of environmental resource materials for the formal and nonformal classroom setting.

BIO 767 Advanced Vertebrate Zoology. 3(2-2), D. Evolutionary relationships of living and extinct vertebrates; analysis of geographic distribution and adaptive radiation. Includes field/lab experiences to be arranged.

BIO 790 Degree Paper. 2(2-0), D. Prerequisite: permission of advisor. Extensive paper on selected topics. Exclusively satisfies requirements for non-thesis option, which also requires one BIO 690 paper to be presented orally to the department. May be repeated to total of 4 hours. Graded Pass/Not Pass only.

BIO 794 Scientific Writing. 2(2-0), F. Organization and methods in scientific writing. Included are discussion of literature searching, scientific methodology, experimental design, proposal writing, figure preparation, editing and oral presentation. Recommended for graduate students in biology, preferably during the first year of graduate study.

BIO 798 Research. 1-6, D. Prerequisite: permission of advisor. Supervised research in special biology areas. May be repeated, but no more than 6 hours may be counted as credit towards the MS degree. Graded Pass/Not Pass only.

BIO 799 Thesis. 1-6, D. Prerequisite: permission of advisor. Independent study connected with preparation of thesis. May be repeated, but no more than 6 hours may be counted as credit towards the MS degree. Graded Pass/Not Pass only.

MISSOURI STATE UNIVERSITY

DEPARTMENT OF CHEMISTRY

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GRADUATE FACULTY

Professor: Richard N. Biagioni, Eric Bosch, Reza Sedaghat-Herati, Tamera S. Jahnke, Mark M. Richter, Shujun Su, Anthony P. Toste
Associate Professor: Bryan Breyfogle, Dean A. Cuebas, Nikolay Gerasimchuk, Erich Steinle
Assistant Professor: Bhaskar Datta, Gary A.J. Meints, Chad J. Stearman
Emeritus Professor: Robert L. Ernst, Wyman K. Grindstaff, Franklin R. Hoggard, James F. O'Brien, Ralph W. Sheets, Vernon J. Thielmann, Clifton C. Thompson, Paul M. Toom, James M. Wilbur, Jr.

MASTER OF SCIENCE, CHEMISTRY

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PROGRAM DESCRIPTION

This program is designed to prepare students to work in industrial or governmental chemistry laboratories, or to pursue doctoral studies in chemistry.

PROGRAM OBJECTIVES

Development of a sound knowledge of chemical principles, acquisition of outstanding research and communication skills, and attainment of an understanding and appreciation of applied chemistry and the importance of multidisciplinary approaches to the solution of scientific problems.

Areas of specialization include analytical chemistry, biochemistry, environmental chemistry, inorganic chemistry, organic chemistry, physical chemistry, polymer chemistry, and chemical education.

Formal courses, graduate seminars, professional advisement, directed research, and a master's thesis will be incorporated into a customized curriculum based on the individual's scholastic background and career goals. On completion of the program, the student will have developed the skills needed for a career in chemical production, development, or research.

ENTRANCE REQUIREMENTS

Students admitted to the graduate chemistry program in full standing must meet the following requirements:

1. A bachelor's degree from an accredited institution in the U.S. or equivalent training in a foreign university.
2. A minimum overall GPA of 3.00 on a 4.00 scale, or a minimum GPA of 3.00 on a 4.00 scale for the last 60 hours of course work.
3. Scores from the verbal and quantitative sections of the Graduate Record Examination. Normally, students are expected to score at or above the 50th percentile on each section of the GRE and to have an overall college GPA of at least 3.00.
4. International applicants are also required to submit a score for the Test of English as a Foreign Language (TOEFL) of not less than 550 on the paper-based or a comparable score of 213 on the computer-based with a minimum of 50th percentile on the Listening Comprehension Section.
5. A minimum undergraduate background in chemistry of two semesters in general chemistry, two in organic chemistry, one in analytical chemistry, and one in inorganic chemistry with a grade of "C" or better in each course and an overall GPA of not less than 3.00.

Applicants lacking the background courses described in item five above may be admitted, but will be required to rectify any of these deficiencies with appropriate course work. These leveling courses will not apply toward the master's degree.

Students who do not meet the grade point standards outlined above may be granted conditional admission to the program. As conditions of admission, students will be required to complete a minimum of 9 hours of specified graduate courses with a GPA of at least 3.00 to be advanced to full standing in the program.

ACCELERATED MASTER'S DEGREE OPTION

Eligible Missouri State University majors in chemistry may apply for preliminary acceptance into the Master of Science program in Chemistry after admission requirements for the accelerated masters option have been satisfied. If accepted, undergraduate courses chosen from CHM 633, CHM 642, CHM 675, and CHM 607, may be counted towards both the undergraduate and graduate degrees, with a maximum of 12 credit hours counted towards both the undergraduate and graduate degrees. This option offers an opportunity for chemistry majors with undergraduate laboratory research experience to complete the requirements for the Master of Science degree in Chemistry in two semesters and a summer after attaining the Bachelor's degree, rather than

the typical four semesters and a summer. Contact the Department of Chemistry for further information and guidelines.

Before enrolling in a course to be counted as both undergraduate and graduate credit and to count the courses towards the masters degree, an undergraduate student must be accepted into the accelerated program and complete a mixed credit form. Acceptance into the program and all approvals must be completed prior to the end of the Change of Schedule Period for the course(s). See the Graduate College for further information.

Admission Requirements

1. Junior standing, a GPA in chemistry of 3.00 or better and an overall GPA of 3.00 or better.
2. Completion of CHM 160, 170, 175, 310, 311, 330, 375, 398, and 399; PHY 123 and 124 or PHY 203 and 204; MTH 287 and 288, or MTH 261 and 280 or MTH 261 and 288 with an overall GPA of 3.00 or better.
3. Undergraduate laboratory research experience in residence in the Department of Chemistry with a supportive recommendation from the student's undergraduate research mentor.
4. Acceptance of applicant by a graduate faculty member who agrees to serve as the student's graduate research mentor.
5. Acceptance of the applicant by the graduate faculty in Chemistry under the accelerated masters option.

DEGREE REQUIREMENTS (A minimum of 32 hours)

1. **Advisory Committee**. Initially, each student will be advised by the departmental coordinator of graduate studies. As soon as possible, the student will select a faculty member to chair a graduate advisory committee consisting of at least four persons. At least one committee member, but not more than two, shall be from outside the chemistry department. This committee will supervise the remainder of the candidate's graduate program.
2. **Program of Study**. The candidate's program will be structured by the advisory committee in consultation with the student. Academic background, professional experience, placement test scores, and academic objectives will be considered in establishing the individual's program.
3. **Chemistry Requirement**. A minimum of 24 hours in chemistry including at least 16 hours from courses numbered 700 or above with at least 6 hours of 700-level chemistry course work in addition to research, thesis, and colloquium. Students who have not passed (with a C or better) undergraduate courses in advanced organic chemistry, instrumental analysis, advanced inorganic chemistry, and physical chemistry will be required to pass (with a grade of C or better) the following course(s) CHM 642, CHM 633, CHM 675, CHM 606 and CHM 607*. Hours received from these courses will count toward the 32 hours required for the master's degree.

   * Students who have had a one-semester physical chemistry course will be given an assessment exam; a score of the 50th percentile or above will satisfy the physical chemistry core course requirement. Students scoring less than the 50th percentile, but higher than the 33rd percentile, will satisfy the physical chemistry core requirement by passing CHM 607.
4. **Colloquium**. 2 hours of credit must be earned in CHM 700, Chemistry Colloquium.
5. **Electives.** Upon approval of the advisory committee, graduate courses from related fields may be selected to a maximum of 8 hours within the 32 hour degree requirement.
6. **Research Requirement**. The maximum credit toward the 32-hour degree requirement is 6 hours of CHM 798 and 6 hours of CHM 799. Submission of a thesis is a specific requirement for the degree. The purpose of the thesis is to demonstrate competence in scientific research and the ability to: choose a research topic of scientific importance; conduct a comprehensive literature search of the problem; design and implement a plan of research; collect and interpret scientific data; and communicate results and findings to peers. An oral defense of the thesis is required.
7. **Comprehensive Examination.** A written comprehensive examination will be administered after most of the course work has been completed. This examination must be passed by the candidate before a degree will be given.

MASTER OF SCIENCE, PLANT SCIENCE

See Department of Fruit Science

MASTER OF NATURAL AND APPLIED SCIENCE

See Interdisciplinary Program: Master of Natural and Applied Science (Accelerated master's program available.)

MASTER OF SCIENCE IN EDUCATION, SECONDARY EDUCATION: CHEMISTRY AREA OF EMPHASIS

Contact Dr. Bryan Breyfogle and refer to the program requirements for the M.S.Ed., Secondary Education under Interdisciplinary Graduate Programs, page 61.

CHEMISTRY REQUIREMENTS

Chemistry course work including a minimum of 3 hours in courses numbered 700 or above. **Total 15 hrs**

MASTER OF SCIENCE IN EDUCATION, SECONDARY EDUCATION: NATURAL SCIENCE AREA OF EMPHASIS

Contact Dr. Tamera Jahnke and refer to the program requirements for the M.S.Ed., Secondary Education under Interdisciplinary Graduate Programs, page 61.

NATURAL SCIENCE PREREQUISITE AND REQUIREMENTS

In this option, students complete a minimum of 15 hours with course work selected from two of the following disciplines: Biology, Chemistry, Geography and/or Geology, Mathematics, and Physics. A minimum of 3 hours of course work numbered 700 or above must be included. The prerequisite requirements are those listed in the departmental statements of both selected academic areas of emphasis.

Courses from one of the above disciplines	9 hrs
Courses from a second of the above disciplines	6 hrs
	Total 15 hrs

CHEMISTRY COURSES

CHM 602 Techniques of Instrumental Analysis. 4(3-3), F. Prerequisite: "C" or better in either CHM 200 or CHM 342; and "C" or better in CHM 302. Recommended Prerequisite: PHY 124 or PHY 204. Applications of instrumental methods for the separation and analysis of materials; included are potentiometry, photometry and chromatography. Does not apply to a Chemistry major if the student passes CHM 702. May be taught concurrently with CHM 502. Cannot receive credit for both CHM 502 and CHM 602.

CHM 605 Fundamentals of Physical Chemistry. 4(3-3), S. Prerequisite: 20 hours of chemistry; and "C" or better in either MTH 287 or MTH 261. A one semester introduction to physical chemistry including the following topics: thermodynamics, solution chemistry, electrochemistry, kinetics, and atomic and molecular structure. Laboratory experiments will illustrate principles of physical chemistry and techniques of analysis. Does not apply to a Chemistry major if the student passes CHM 606. May be taught concurrently with CHM 505. Cannot receive credit for both CHM 505 and CHM 605.

CHM 606 Physical Chemistry I. 3(3-0), F. Prerequisite: "C" or better in CHM 170; and MTH 280 or MTH 288 or concurrent enrollment in MTH 280 or MTH 288. Recommended Prerequisite: PHY 124 or PHY 204. Chemical thermodynamics; kinetic theory of gases. A grade of "C" or better is required in this course in order to take CHM 607. May be taught concurrently with CHM 506. Cannot receive credit for both CHM 506 and CHM 606.

CHM 607 Physical Chemistry II. 3(3-0), S. Prerequisite: "C" grade or better in CHM 506 or CHM 606. Continuation of CHM 606. Kinetics, quantum theory and spectroscopy. May be taught concurrently with CHM 507. Cannot receive credit for both CHM 507 and CHM 607.

CHM 608 Physical Chemistry Laboratory I. 2(0-4), F. Prerequisite: "C" or better in CHM 302; and "C" or better in CHM 506 or CHM 606 or concurrent enrollment in CHM 506 or CHM 606. Experiments in physical chemistry employing principles and techniques reflecting material presented in CHM 506, i.e. thermodynamics and chemical kinetics. May be taught concurrently with CHM 508. Cannot receive credit for both CHM 508 and CHM 608.

CHM 609 Physical Chemistry Laboratory II. 2(0-4), S. Prerequisite: CHM 507 or CHM 607 or concurrent enrollment; and CHM 508 or CHM 608. Experiments in physical chemistry employing principles and techniques reflecting material presented in CHM 507, i.e. quantum mechanics and spectroscopy. May be taught concurrently with CHM 509. Cannot receive credit for both CHM 509 and CHM 609.

CHM 614 Polymer Chemistry. 3(3-0), SE. Prerequisite: "C" or better in CHM 343 or CHM 344; and CHM 505 or CHM 605 or CHM 506 or CHM 606. Morphology and chemical structure, polymer characterization, chemical structure and polymer properties, vinyl and non-vinyl polymers and mechanism of formation. Inorganic and partially inorganic polymers. May be taught concurrently with CHM 514. Cannot receive credit for both CHM 514 and CHM 614.

CHM 633 Advanced Analytical Methods. 4(3-3), F Prerequisite: "C" or better in CHM 302. Principles and techniques of modern instrumental methods used in chemical analysis, with emphasis on the fundamental physical and chemical theories and principles. Topics covered include atomic and molecular spectroscopy, electrochemistry, mass spectrometry, and separations. May be taught concurrently with CHM 533. Cannot receive credit for both CHM 533 and CHM 633.

CHM 642 Advanced Organic Chemistry. 3(3-0), F. Prerequisite: "C" grade or better in CHM 343 or CHM 344. Structure, reaction mechanisms, stereochemistry and other topics of theoretical nature in organic and polymer chemistry. May be taught concurrently with CHM 542. Cannot receive credit for both CHM 542 and CHM 642.

CHM 652 Biochemistry II. 3(3-0), S. Prerequisite: "C" or better in CHM 452. Bioenergetics—Metabolism of biomolecules including carbohydrates, lipids, amino acids and nucleotides. Photosynthesis. Nitrogen metabolism. Mechanisms of hormone action. May be taught concurrently with CHM 552. Cannot receive credit for both CHM 552 and CHM 652.

CHM 653 Advanced Biochemistry Laboratory. 2(0-4), D. Prerequisite: CHM 453; and CHM 552 or CHM 652 concurrent enrollment in CHM 552 or CHM 652. Emphasis on modern techniques in the biochemistry laboratory; enzymology, protein purification and analysis; protein structure determination; isoelectric focusing; HPLC; trace techniques. Supplemental course fee. May be taught concurrently with CHM 553. Cannot receive credit for both CHM 553 and CHM 653.

CHM 674 Intermediate Inorganic Chemistry. 3(3-0), F. Structure of atoms, introduction to bonding, symmetry in chemistry, inorganic spectroscopy, and descriptive inorganic chemistry. A grade of "C" or better is required in this course in order to take CHM 675. May be taught concurrently with CHM 375. Cannot receive credit for both CHM 375 and CHM 674. May be taught concurrently with CHM 574. Cannot receive credit for both CHM 574 and CHM 674.

CHM 675 Advanced Inorganic Chemistry. 3(3-0), S. Prerequisite: "C" or better in CHM 375; and CHM 507 or CHM 607 or concurrent enrollment in CHM 507 or CHM 607. Theories and techniques of modern inorganic chemistry; correlation of theories with inorganic compounds. May be taught concurrently with CHM 575. Cannot receive credit for both CHM 575 and CHM 675.

CHM 697 Special Topics in Chemistry. 1-3, D. Prerequisite: 18 hours of chemistry. Selected topics of a theoretical or applied nature. May be repeated up to a total of 6 hours with differing topics. May be taught concurrently with CHM 597. Cannot receive credit for both CHM 597 and CHM 697.

CHM 700 Chemistry Colloquium. 1(1-0), F,S. A series of oral presentations on new developments in chemistry. Presentations to be made by faculty members, students, and guest speakers from industry and academe. One of the requirements of this course is an oral presentation. May be repeated, but not more than 2 hours may be counted toward the 32-hour requirement for the MS in Chemistry degree.

CHM 701 Chemistry Seminar. 1(1-0), F,S. Attendance at oral presentations on new developments in chemistry. Presentations may include those made by departmental faculty members, departmental graduate students, guest speakers from industry and academe and ACS tour speakers. All graduate students not enrolled in CHM 700 must be enrolled in CHM 701. Hours earned will not count toward the 32-hour requirement for the MS in Chemistry degree. Graded Pass/Not Pass only.

CHM 702 Advanced Techniques in Chemical Analysis. 3(3-0), SO. Prerequisite CHM 602 or CHM 633. Advanced topics in modern instrumental analysis, instrumentation, and methods, including data acquisition methods, data manipulation and analysis, and electronics.

CHM 710 Special Topics in Chemical Education. 1-3, D. Prerequisite: coursework sufficient to meet Missouri certification standards in chemistry for secondary teaching or permission. A single topic of current interest in the teaching of chemistry will be considered. May be repeated to a total of 9 hours provided the topics are different.

CHM 720 Topics in Theoretical Chemistry. 3(3-0), D. Prerequisite: coursework sufficient to meet Missouri certification standards in chemistry for secondary teaching or permission. Nature of matter including atomic structure, chemical bonding and spectroscopy.

CHM 735 Investigation in Chemistry for Teachers. 3(1-4), S. Prerequisite: coursework sufficient to meet Missouri certification standards for secondary/middle school science teaching. Techniques in performing science investigation with application to secondary and middle school science. May be taught concurrently with CHM 435. Cannot receive credit for both CHM 435 and CHM 735.

CHM 740 Seminar. 2(2-0), D. Extensive paper on selected topics to be read before staff seminars. May be repeated to total 4 hours.

CHM 742 Physical Organic Chemistry. 3(3-0), D. Prerequisite: CHM 642. An in-depth study of the experimental techniques and physical principles used for the determination of organic reaction mechanisms.

CHM 752 Advanced Topics in Biochemistry. 3(3-0), SO. Prerequisite: CHM 652. An advanced topic in biochemistry will be addressed via faculty lectures and student projects. Examples of proposed topics include: carbohydrates, the cell surface, and physical biochemistry. Variable content course. May be repeated to a total of 6 hours with differing topics.

CHM 760 Chemistry of Environmental Systems I. 3(3-0), F. Chemistry of pollution. Sources, effects, detection and abatement of pollutants in air, water, and soil. May be taught concurrently with CHM 460. Cannot receive credit for both CHM 460 and CHM 760.

CHM 761 Chemistry of Environmental Systems II. 3(3-0), S. Prerequisite: CHM 760. Chemistry of pollution. Sources, effects, detection and abatement of pollutants in air, water and soil. May be taught concurrently with CHM 461. Cannot receive credit for both CHM 461 and CHM 761.

CHM 762 Chemistry of Environmental Systems Laboratory. 2(0-4), S. Prerequisite: CHM 760 or concurrent enrollment. Techniques and procedures for environmental monitoring to test natural samples. Applications and limitations of wet chemical and instrumental methods such as atomic absorption, gas chromatography, and absorption spectrophotometry. May be taught concurrently with CHM 462. Cannot receive credit for both CHM 462 and CHM 762.

CHM 770 Chemical Kinetics. 3(3-0), FO. Prerequisite: CHM 606. Fundamental concepts of chemical kinetics and dynamics, from both macroscopic and molecular level perspectives. An emphasis will be placed on the interpretation of gas, liquid, surface and catalyst reaction kinetics and mechanisms.

CHM 771 Chemical Bonding. 3(3-0), FE. Prerequisite: CHM 607. Quantum mechanics; atomic and molecular structure; computational procedures. Independent study project required.

CHM 775 Organometallic Chemistry. 3(3-0), FE. Prerequisite: CHM 675. An in-depth examination of the structure, properties, and reactions of molecules containing one or more metal atoms bonded to organic fragments.

CHM 790 Advanced Topics in Chemistry. 1-3, D. Detailed treatment of various advanced topics in chemistry. Topics may include: water analysis, physical chemistry of macromolecules, chemistry of natural products, surface chemistry, and forensic chemistry. Variable content course. May be repeated to a total of 6 hours with differing topics.

Radiation and the Environment 3(3-0) SE. Students will examine radioactivity in the environment in terms of its nature and causes, its impact on the biosphere, techniques for detecting its presence and measuring levels of contamination, ways of coping with its effects while capitalizing on its benefits, and possible methods for ameliorating some of the problems it creates.

CHM 798 Research. 1-4, F,S. Supervised research in special chemistry areas. May be repeated, but not more than 6 hours of CHM 798 may be counted toward the 32-hour requirement for the MS degree.

CHM 799 Thesis. 1-6, D. Independent research and study connected with preparation of thesis. Not more than 6 hours of CHM 799 may be counted toward the 32-hour requirement for the MS degree.

DEPARTMENT OF COMPUTER SCIENCE

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GRADUATE FACULTY

Professor: Lloyd A. Smith, Kenneth Vollmar, Yang Wang
Associate Professor: Jamil Saquer
Assistant Professor: Hui Liu
Emeritus Professor: Melvin V. Foster, Ivon Lowsley, Jr.

No master's degree program is offered in Computer Science. However, the department participates in the Interdisciplinary Master of Natural and Applied Science program. The following courses may be taken for graduate credit by students admitted to graduate study at Missouri State University.

MASTER OF NATURAL AND APPLIED SCIENCE

See Interdisciplinary Program: Master of Natural and Applied Science. (Accelerated master's program available.)

COMPUTER SCIENCE COURSES

CSC 600 Hardware, Software, and Troubleshooting Personal Computers. 3(2-2) D. An introduction to the installation, maintenance, troubleshooting, upgrading, simple repair, and management of personal computers found in educational settings. This course will provide numerous laboratory experiences providing hands-on experience with the goal of enabling students to support personal computer laboratories found in PK-12 schools. May be taught concurrently with CSC 500. Cannot receive credit for both CSC 500 and CSC 600.

CSC 605 Web-Based Resources in Educational Settings. 2(2-0) D. An introduction to the design, implementation, and management of World Wide Web resources over the Internet and Intranet networks. Topics include Internet overview, web authoring, web programming, server setting and maintenance. The objective of the course is to know tools (HTML, JAVAScript, and JAVA applets, and Internet Server software, and Navigator/ Internet Explorer software packages), and their applicability in WWW design and management in PK-12 school settings. May be taught concurrently with CSC 505. Cannot receive credit for both CSC 505 and CSC 605.

CSC 610 Networking and Telecommunications in Educational Settings. 2(2-0) D. An introduction to networking and data communications from an educator's perspective. The course will examine the necessary computer hardware, software, and personnel resources relevant to networking and data communication requirements in various educational settings. Local Area Networks, Wide Area Networks, Network Interconnections, and the Internet will be addressed. May be taught concurrently with CSC 510. Cannot receive credit for both CSC 510 and CSC 610.

CSC 621 Compiler Construction. 4(3-2) D. Topics include lexical analysis, parsing, symbol tables, type checking, run-time organization, code generation, basic code optimization, and the use of compiler development tools. The student must write a complete compiler for a small imperative programming language. May be taught concurrently with CSC 521. Cannot receive credit for both CSC 521 and CSC 621.

CSC 625 Computer Graphics. 3(3-0), F. Introduction to computer graphics, with an emphasis on application programming. Algorithms for two dimensional graphics, including windowing, clipping, and transformations; algorithms for three dimensional graphics, including viewing, transformations, and removal of hidden lines and surfaces. Data structures for graphics and interactive techniques stressed. May be taught concurrently with CSC 525. Cannot receive credit for both CSC 625 and CSC 525.

CSC 626 Methods of Optimization. 3(3-0) D. Convex sets, classical optimization of functions, constrained optimiution, search techniques, linear and nonlinear optimization, applications to applied problems. May be taught concurrently with CSC 526. Cannot receive credit for both CSC 526 and CSC 626.

CSC 635 Data Mining. 3(3-0), D. The emerging technology of data mining; the automated extraction of patterns and information from data. The focus will be on understanding the algorithms underlying data mining and on the practical use of those algorithms. Students will use data mining software to analyze collections of data. May be taught concurrently with CSC 535. Cannot receive credit for both CSC 635 and CSC 535.

CSC 640 Artificial Intelligence. 3(3-0), S. Techniques of artificial intelligence, including study of expert systems, natural language processing, search strategies, computer vision and robotics. May be taught concurrently with CSC 540. Cannot receive credit for both CSC 640 and CSC 540.

CSC 645 Computer Speech, Music and Images. 3(3-0), D. This is an applied course focusing on the technical aspects of computer-based multimedia-speech, music, audio, and video. In any given semester, the focus may be more on audio or image processing, or it may be equally balanced between the two. Topics include multimedia data capture and representation, methods of data compression, multimedia information retrieval, and multimedia standards. May be taught concurrently with CSC 545. Cannot receive credit for both CSC 645 and CSC 545.

CSC 665 Computer Networks. 3(3-0), F. An introduction to the theory, concepts and techniques upon which modern computer networks and telecommunication systems are based. The emphasis will be on layered network architectures, the design frameworks for both local and wide area networks and communication protocols. May be taught concurrently with CSC 565. Cannot receive credit for both CSC 665 and CSC 565.

CSC 667 Wireless Networks. 3(3-0), S. An introduction to the fundamental theory, concepts and techniques of wireless communication, wireless networks, network architecture, and wireless applications. Students will gain an understanding of the significance that wireless systems and user mobility have on the construction and handling of a data or telecommunications network. Topics include wireless and ad hoc networks, enabling technologies, multiplexing, protocol design, network security, and quality of service. May be taught concurrently with CSC 567. Cannot receive credit for both CSC 667 and CSC 567.

CSC 687 Computing for Bioinformatics. 3(3-0), D. This course focuses on computational techniques used in bioinformatics. Topics will include nucleotide and amino acid data representation, sequence alignment, coding sequence prediction, and use of statistical models. Students will learn to use bioinformatics libraries with a script language such as Python or Perl. May be taught concurrently with CSC 587. Cannot receive credit for both CSC 687 and CSC 587.

CSC 690 Advanced Topics in Computer Science. 1-4, D. Detailed consideration of advanced topics in the field of Computer Science. Topics will change, and this course may be repeated with differing topics. May be taught concurrently with CSC 590. Cannot receive credit for both CSC 690 and CSC 590.

CSC 696 Special Readings. 1-3, F, S. Prerequisite: permission of department head. Periodic conferences with an advisor are required. May be repeated to a total of 6 hours. May be taught concurrently with CSC 596. Cannot receive credit for both CSC 596 and CSC 696.

CSC 798 Research in Computer Science. 1-4, F,S. Prerequisite: permission of department head. Supervised research in computer science. May be repeated, but no more than 6 hours may count toward the Master of Natural and Applied Science degree.

CSC 799 Thesis. 1-6, D. Prerequisite: permission of instructor. Independent research and study connected with preparation of thesis. No more than 6 hours may count toward the Master of Natural and Applied Science degree.

DEPARTMENT OF FASHION AND INTERIOR DESIGN

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GRADUATE FACULTY

Professor: Michele M. Granger, Carrie J. Ireland
Instructor: Debra Agee
Emeritus Professor: Edna Bell, Debra S. McDowell, Loanna M. Thompson, Joyce J. Waldron

MASTER OF SCIENCE IN EDUCATION, SECONDARY EDUCATION: VOCATIONAL FAMILY AND CONSUMER SCIENCES AREA OF EMPHASIS

Contact Debra Agee and see program requirements for the M.S.Ed., Secondary Education under Interdisciplinary Graduate Programs, page 61.

FAMILY AND CONSUMER SCIENCES REQUIREMENTS

A minimum of 3 hours of course work must be in Consumer and Family Studies courses numbered 700 or above.

Consumer and Family Studies courses **15 Hours**

CLOTHING AND TEXTILE COURSES

CTM 680 Senior Collection: Line Development. 3(1-4) S. Production of an apparel line from the conceptualization to the construction of sample garments. Three to five garments required in the student designer's line. A grade of "C" or better is required for graduation. Supplemental course fee. May be taught concurrently with CTM 580. Cannot receive credit for both CTM 580 and CTM 680.

CTM 683 Product Performance Evaluation. 3(2-2), S. Testing and Analysis of textile products to determine quality, performance, use and serviceability. May be taught concurrently with CTM 583. Cannot receive credit for both CTM 583 and CTM 683.

CTM 685 Establishing a Fashion Business. 3 (3-0), S. Entrepreneurial concepts of opening a business through the development of a business plan. A grade of "C" or better is required for graduation.

CTM 782 Graduate Seminar in Clothing and Textiles. 2(2-0), S. Prerequisite: 12 hours of graduate credit. Selected topics in clothing and textiles that involve the areas of apparel manufacturing, fashion merchandising, and management trends are systematically explored through critical analysis of literature and through an individual research project. May be repeated for credit. A total of 4 hours may be applied to a degree program.

FAMILY AND CONSUMER STUDIES COURSES

CFS 600 Issues in Family and Consumer Sciences. 1-3, D. Advanced inquiry into specialized areas of study in Family and Consumer Sciences such as: Blended Families, Historic Building Preservation, Textile Conservation, Preservation Techniques, Advanced Culinary Techniques, and International Trends in Hospitality. May be repeated to a total of 6 hours when topics change. Variable content course. May be taught concurrently with CFS 500. Cannot receive credit for both CFS 500 and CFS 600.

CFS 602 Study Tour. 1-3, D. Study of and/or visits to mills, factories, stores, museums, hospitals, laboratories, design studios and/or trade markets. Supplemental course fee (variable by section). May be taught concurrently with CFS 502. Cannot receive credit for both CFS 502 and CFS 602.

CFS 607 Student Organizations in Family and Consumer Sciences. 1(1-0) F. Prerequisite: concurrent enrollment in CFS 612. Methods of organizing student groups in Family and Consumer Sciences programs, techniques of working with students in individual and group projects; leadership training. May be taught concurrently with CFS 507. Cannot receive credit for both CFS 507 and CFS 607.

CFS 612 Teaching Family and Consumer Sciences. 3(2-2) F. Prerequisite: concurrent enrollment in CFS 607. An overview of the philosophy and history of family and consumer sciences education; includes curriculum building with emphasis on critical thinking and reflective decision-making, problem-based learning, and the development of authentic assessments. Includes the planning of lessons, units, and development of teaching materials in the family and consumer sciences discipline and practice implementation of such lessons. Completion of checkpoint II for the Professional Portfolio is a component of this course. A grade of "C" or better is required in this course. May be taught concurrently with CFS 512. Cannot receive credit for both CFS 512 and CFS 612.

CFS 615 Organization of Family and Consumer Sciences Programs. 3(2-2) S. Prerequisite: CFS 607 and CFS 612. Investigation of the organization and administration of family and consumer sciences programs; identification of types of programs; program planning, program evaluation and career counseling with emphasis on critical thinking and reflective decision-making. A grade of "C" or better is required in this course. May be taught concurrently with CFS 515. Cannot receive credit for both CFS 515 and CFS 615.

CFS 701 Supervision of Student Teachers in Family and Consumer Sciences. 3 (3-0), D. Prerequisite: teaching experience in Family and Consumer Sciences; and permission. Experiences in creating an environment that will encourage Family and Consumer Sciences student teachers to realize their potentials and gain competence in teaching.

CFS 795 Advanced Technical Practice. 3, D. Prerequisite: permission. Work in CAD, EDI, Child Life, Mental Health, Hospitality, clinical hospitals, schools, manufacturing, retailing, and/or other settings. Ninety clock hours required.

CFS 796 Practicum. 4(0-8), D. Prerequisite: permission. The assumption of responsibilities at an approved practicum site under the direction of a professor and practicum site supervisor.

MISSOURI STATE UNIVERSITY

DEPARTMENT OF GEOGRAPHY, GEOLOGY, AND PLANNING

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GRADUATE FACULTY

Professor: John C. Catau, William T. Corcoran, Melida Gutierrez, Dimitri Ioannides, Rajinder Jutla, Erwin J. Mantei, Kevin L. Mickus, Robert T. Pavlowsky, Thomas G. Plymate, Paul A. Rollinson, Charles W. Rovey II,
Associate Professor: Kevin R. Evans, Douglas R. Gouzie, Judith L. Meyer
Assistant Professor: Alice Jill Black, Mario Daoust, Jun Luo, Diane M. May, Xin Miao, Xiaomin Qiu
Emeritus Professor: David A. Castillon, William H. Cheek, Stanley C. Fagerlin, Russell L. Gerlach, Elias Johnson, Vincent E. Kurtz, Thomas D. Moeglin, Milton D. Rafferty

MASTER OF SCIENCE, GEOSPATIAL SCIENCES IN GEOGRAPHY AND GEOLOGY

Robert T. Pavlowsky, Graduate Director
Temple Hall, Room 321; Phone (417) 836-8473
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PROGRAM DESCRIPTION

The program of study is designed to provide professional training and develop scholarly analytical skills in Geospatial Science with applications in one of three areas: 1) Physical Geography; 2) Human Geography and/or Planning; or 3) Geology. This program emphasizes the integration of the theoretical frameworks of Geography and Geology and Geospatial Science principles. By combining these areas, students will be able to address research problems regarding environmental issues and resource management.

The core curriculum consists of course work in Geographic Information Science (GIS), Remote Sensing, research methods and research presentations, both written and oral. Students are encouraged to develop, with their advisors, a program that fits their individual talents and goals. The department recommends that students choose a research concentration in Physical Geography, Human Geography and/or Planning, or Geology. If a student intends to pursue research outside these concentration areas, he/she should contact the program director and prospective advisor, if possible, before applying to the program. Admission is granted to students with demonstrated academic competences who are interested in a professional career in geography or geology.

Funding for graduate students in Geospatial Sciences is available through application for competitive graduate assistantships which carry both a stipend and fee waiver. Applications for graduate assistantships should be submitted directly to the Graduate Program Director in the Department of Geography, Geology and Planning. Additional graduate assistantships may also be available through listings by other departments and offices.

ADMISSION REQUIREMENTS

The Department's Graduate Admissions Committee requests the following materials from each applicant:

1. An application for admission to the Graduate School;
2. Official transcripts from all previously attended institutions of higher education;
3. Graduate Record Examination scores;
4. Three letters of recommendation from persons familiar with the candidate's academic abilities and professional potential sent to the MS Program Director.
5. Separate application to the MS Program Director for a graduate assistantship, if desired.

Since no specific undergraduate major is required, some students may be admitted on a conditional basis if they lack sufficient academic experience to take the required core courses. In these cases, specific undergraduate courses may be required before full admission is granted. Undergraduates interested in this program are encouraged to include courses in cartography, aerial photography interpretation, statistics, chemistry, biology and environmental science. Calculus and physics may be required for studies in some areas of geology.

ADVISEMENT

1. Each student should consult with the department's general graduate advisor before registering for the first semester of classes.
2. Each student is also encouraged to identify a general thesis topic as soon as possible. This will permit the selection of an appropriate faculty advisor who, in consultation with the student, will help to identify a second member of the student's advisory committee. The third member of this committee will be assigned by the department.

3. Once the membership of the advisory committee has been established, the student should rely upon its members, but especially the chairperson, for assistance in the selection of his/her elective courses, and for advice and direction in the thesis research.
4. Until such time as the advisory committee has been formed, the student should continue to consult with the department's graduate advisor.

DEGREE REQUIREMENTS (A minimum of 33 hrs)

1. **Required Geospatial Sciences Core** **15 hrs**

GEO 700	Introduction to Graduate Study in Geospatial Sciences	3 hrs
GEO 701	Rsrch Methods in Geospatial Sciences	3 hrs
GEO 651	Remote Sensing	3 hrs
GEO 666	Advanced Geographic Inform. Science	3 hrs
One of the following		3 hrs
GEO 668	Thematic Cartography	
GEO 672	Introduction to Photogrammetry and Spatial Statistics	
GEO 673	Geographic Info. Science Programming	
GEO 678	Remote Sensing Digital Image Processing	

Students who do not have adequate background in statistical analysis from their undergraduate course work are strongly encouraged to take at least one of the following : 3 hrs

MTH 645	Applied Statistics
MTH 646	Analysis of Variance & Design of Experiments
MTH 647	Applied Regression Analysis
MTH 648	Applied Time Series Analysis

2. **Research Requirement (complete one)**

Thesis Option. A student can take up to 6 hours of GRY 799 or GLG 799. Successful completion of a thesis and thesis defense is required.

Non-Thesis Option. Students choosing the non-thesis option must complete two research projects and write scholarly reports for each project. Up to a total of 3 hours of credit can be received for these two projects under GEO 780. The results of both research projects must be orally defended and the student's advisor and another graduate faculty member must approve written reports on the research projects. Non-thesis students must present at least one of these papers as a departmental seminar as part of course requirements of GEO 780. Students in the non-thesis option are not allowed to count thesis hours toward the 33 hour degree requirement.

3. **Additional Course Requirements.** Students in both the thesis and non-thesis options must complete an additional 18 hours of graduate course work beyond the required 15-hour core. Students choosing to complete a thesis may count up to 6 credit hours of GRY 799 or GLG 799 toward this 18 hour requirement. For all students, at least 17 credit hours of course work must be at the 700 level, including thesis credits. Students must complete a program of study worksheet by the end of their first academic semester. Before enrolling in the 12th hour of graduate credit, the student, an academic advisor, and the Graduate Program Director must agree upon and sign an Advisor Approved Program of Study.

4. **Comprehensive Examination.**A written comprehensive examination must be taken following completion of 15 hours of courses. Students will be provided reading lists specific to the required core and their selected track of study. The examination questions will be drawn from these reading lists and students must pass both sections of the examination. A student may repeat the examination, or section of the examination, upon recommendation of the Program Director and approval of the department chair. Students who have not passed the comprehensive examination upon completion of three academic semesters of study will not be permitted to continue in the program. If a student opts to change tracks after completing the comprehensive examination, the student must take and pass the examination specific to the new selected track before a degree will be awarded.

Reading Lists. Materials to be included on the reading lists should cover subject matter that the student is already expected to be familiar with when starting the program or should be able to read and digest by the time of the exam. Students are to be provided the reading lists when starting the program. One copy of the reading material will be on reserve in the library.

Exam Period and Questions. The number and type of questions to be included on the examination are to be determined by the Geospatial Science Comprehensive Exam Committee. Question types could be multiple choice and short answer/essay. Students are to answer all questions.

The Geospatial Sciences Comprehensive Examination Committee is to prepare the exam questions. The committee should determine what constitutes a passing mark for the exam.

5. **Research Concentrations.** The Department of Geography, Geology and Planning has identified three areas of research concentration for prospective students. Students are strongly encouraged to select a research topic in one of these concentration areas.

Physical Geography

Students interested in physical geography can select a research topic in fluvial geomorphology, water quality and watershed management, or climatology. Students should integrate geospatial science with physical geography when doing either a thesis or non-thesis research project. Students selecting this concentration would normally take at least two of the following courses:

GRY 625 Environmental Hazards
GRY 635 Global Climate and Weather Cycles
GRY 645 Global Environmental Change
GRY 650 Fluvial Geomorphology
GRY 731 Environmental Assessment
GRY 751 Topics in Advanced Physical Geography
GEO 770 Advanced Field & Laboratory Methods

Human Geography and/or Planning

Students interested in human geography and/or planning can select a research topic in land use assessment, urban design, community and regional planning, neighborhood planning, transportation planning, or tourism planning and development. Students should integrate geospatial science with human geography and/or planning when doing either a thesis or non-thesis research project. Students selecting this concentration would normally take at least two of the following courses:

GRY 610 Tourism and Sustainability
GRY 625 Environmental Hazards
GRY 645 Global Environmental Change
GRY 731 Environmental Assessment
PLN 673 Urban Design and Preservation
PLN 674 Open Space and Recreation Planning
PLN 705 Social Planning
PLN 670 Planning Law
PLN 671 Land Use Planning

Geology

Students interested in geology can select a research topic in environmental geochemistry, geohydrology, karst geomorphology, stratigraphy, or geophysics. Students should integrate geospatial science with geology when doing either a thesis or non-thesis research project. Students selecting this concentration would normally take at least two of the following courses.

GLG 670 Principles of Stratigraphy
GLG 681 Geochemical Techniques
GLG 690 Applied Geophysics
GLG 672 Geohydrology
GLG 673 Engineering Geology
GLG 680 Geochemistry

Students interested in research topics outside of these concentrations should consult with the Graduate Director and a possible advisor before beginning the program.

ACCELERATED MASTER'S DEGREE OPTION

Eligible Missouri State University undergraduate majors in Geography, Geospatial Sciences, Geology, and Planning may apply for early admission to the Master of Science in Geospatial Sciences. Once accepted for early admission, students will be able to take up to 12 credit hours that apply to both their undergraduate and graduate program. This option allows students with advanced course work in Geography, Geospatial Sciences, Geology, or Planning to complete a masters degree in three full semesters and one summer semester. Students can choose from GEO 651, GEO 666, GEO 668, GLG 690, GLG 672, GLG 673, GLG 680. Contact the Department of Geography, Geology and Planning for further information and guidelines.

Before enrolling in courses to be counted for both undergraduate and graduate credit, an undergraduate student must be accepted into the accelerated masters program AND receive prior approval from the Graduate Program Director, Department Head of the undergraduate program and the Graduate College Dean (on a Mixed Credit Form). Acceptance to the program and all approvals must be completed prior to the end of change of schedule period for the course(s). See the Graduate College for further information.

Admission Requirements.

1. Junior standing, majoring in Geography, Geospatial Sciences, Geology or Planning with an overall GPA of 3.25 or better.
2. Majors in Geology must have completed GLG 333 and have a GPA of 3.25 in all Geology courses. Majors in Geography and Geospatial Sciences must have completed GEO 661 and have a GPA of 3.25 in all geography and geospatial sciences courses.
3. Acceptance of applicant by a graduate faculty member who agrees to serve as the student's graduate research advisor.
4. Acceptance of applicant by the graduate faculty in Geography, Geology and Planning under the accelerated master's option.

MASTER OF SCIENCE, ADMINISTRATIVE STUDIES: ENVIRONMENTAL MANAGEMENT OPTION

The Department of Geography, Geology and Planning participates in the Master of Science, Administrative Studies (MSAS) degree. The MSAS is an interdisciplinary program composed of courses from departments and colleges across campus. The program, which includes a significant online component, is administered by a faculty committee and located in the Graduate College. For more information on the MSAS, see page 59.

MSAS Environmental Management Option:

Required (6 hours)

GRY 731 Environmental Assessment	3 hrs
ECO 640 Economics of the Environment	3 hrs

Elective hours (6 hours chosen in consultation with advisor)

BIO 632 Principles of Fisheries Management	3 hrs
BIO 662 Limnology	3 hrs
BIO 689 Game Management	3 hrs
BIO 726 Advanced Limnology Methods	3 hrs
CHM 760 Chemistry of Environmental Systems	3 hrs
PLN 671 Land Use Planning	3 hrs
PLN 674 Open Space & Recreation Planning	3 hrs
GRY 748 Physiography & Resource Planning	3 hrs
PLN 670 Planning Law	3 hrs

MASTER OF NATURAL AND APPLIED SCIENCE

See separate program listing under the "College of Natural and Applied Sciences". (Accelerated masters opportunity available.)

MASTER OF SCIENCE IN EDUCATION, SECONDARY EDUCATION: EARTH SCIENCE AREA OF EMPHASIS

Contact Dr. Melida Gutierrez and refer to program requirements for the M.S.Ed., Secondary Education under Interdisciplinary Graduate Programs, page 61.

PREREQUISITE EARTH SCIENCE REQUIREMENTS

A minimum of 24 hours in Science and/or Mathematics.

EARTH SCIENCE REQUIREMENTS

GLG 701	Geology for Secondary Teachers I	3 hrs
GLG 702	Geology for Secondary Teachers II	3 hrs
Additional Geography and Geology course work		9 hrs
		Total 15 hrs

MASTER OF SCIENCE IN EDUCATION, SECONDARY EDUCATION: GEOGRAPHY AREA OF EMPHASIS

Contact Dr. Judith Meyer and see program requirements for the M.S.Ed., Secondary Education under Interdisciplinary Graduate Programs, page 61.

PREREQUISITE GEOGRAPHY REQUIREMENTS

A minimum of 24 hours in the social sciences including Economics, Geography, History, Political Science, Psychology, and Sociology.

GEOGRAPHY REQUIREMENTS

GRY 700	Cultural Geo. for Sec. Teachers I	3 hrs
GRY 703	Cultural Geo. for Sec. Teachers II	3 hrs
Additional Geography course work		9 hrs
		Total 15 hrs

MASTER OF SCIENCE IN EDUCATION, SECONDARY EDUCATION: NATURAL SCIENCE AREA OF EMPHASIS

Contact Dr. Tamera Jahnke and see program requirements for the M.S.Ed., Secondary Education under Interdisciplinary Graduate Programs, page 61.

NATURAL SCIENCE PREREQUISITE AND REQUIREMENTS

In this option, students complete a minimum of 15 hours with course work selected from two of the following disciplines: Biology, Chemistry, Geography and/or Geology, Mathematics, and Physics. A minimum of 3 hours of course work numbered 700 or above must be included. The prerequisite requirements are those listed in the departmental statements of both selected academic areas of emphasis.

Courses from one of the above disciplines	9 hrs
Courses from a second of the above disciplines	6 hrs
	Total 15 hrs

GEOSPATIAL INFORMATION SCIENCES GRADUATE CERTIFICATE

PROGRAM DESCRIPTION

This certificate program is designed to provide graduate-level education in Geospatial Sciences including such focus areas as Geographic Information Systems, Internet Mapping, Military and Intelligence Applications, and Remote Sensing. It is anticipated that this program would be attractive to working professionals in such organizations as the United States Geological Survey, the National Geospatial-Intelligence Agency, and the United States Army and Army Corps of Engineers. This certificate is being offered jointly by the Geological Engineering degree program in the Department of Geological Sciences and Engineering within the School of Materials, Energy and Earth Resources at the Missouri University of Science and Technology (MS&T) and the Department of Geography, Geology and Planning at Missouri State University. Faculty members from MS&T and Missouri State will jointly organize, administer and offer the graduate certificate as described below.

This certificate will uniquely utilize the complementary expertise at the MS&T and Missouri State to provide a wide range of courses and topic areas so that students can customize their program of study and focus on particular interests.

ADMISSION CRITERIA

The Geospatial Information Sciences Certificate program is open to all persons holding a B.S., B.A., M.S., or Ph.D. degree. Students must, of course, satisfy all prerequisites for any courses they take in the program; or they must obtain instructor approval to waive any prerequisites. Once admitted to the program, the student must take a minimum of four courses as designated and approved by the program director and must have an average cumulative grade point average of 3.00 or better to receive the certificate.

Students who complete the four-course requirements for the certificate with a grade of B or better in each course may be admitted directly to the respective M.S. program in each institution if they so choose. This admission does not waive the necessity for students to take required prerequisites for other required courses that are part of the M.S. program. The certificate credits taken will count toward the requirement for their M.S. degree.

CURRICULUM 12 Hours Total

It is anticipated that a student will typically complete two courses from those offered by MS&T and two courses from those offered by Missouri State University. Courses will be offered both at off-campus locations (such as at a USGS or NGA facility) and at the respective campuses. Some courses will be available as on-line distance offerings in the future. Each university will appoint a program technical coordinator who will serve as primary academic advisor and liaison for student in the program. Courses should be selected in consultation with and approved by these program coordinators to insure proper prerequisite are satisfied and that duplication is avoided. A summary of courses tentatively planned to be offered is listed below:

MS&T courses:

GE 315	Statistical Methods in Environmental Geology and Engineering
GE 342	Military Geology
GE 344	Remote Sensing Technology
GE 346	Applications of Geog. Info. Systems
GE 446	Adv. Remote Sensing & Image Processing

Missouri State courses:

GEO 651	Remote Sensing
GEO 661	Intermediate Geographic Information Science
GEO 662	Internet Geospatial Science
GEO 673	Geographic Inform. Science Programming
GEO 666	Advanced Geographic Information Science
GEO 678	Remote Sensing Digital Image Processing

Other courses approved by the MS&T and Missouri State University faculty may be substituted for any of the above listed courses on a case-by-case basis. The certificate program technical coordinators must approve the substitution prior to enrolling in any course.

COMPLETION REQUIREMENTS

Students must have an overall grade point average of 3.00 for completion of the certificate program.

GEOLOGY COURSES

GLG 623 Coastal Marine Geology. 2(2-0), Su. Prerequisite: permission; and concurrent enrollment in GLG 624. A study of inshore and nearshore geologic processes, sedimentation patterns and landform development. Must be taken at Gulf Coast Research Laboratory, Ocean Springs, Mississippi. May be taught concurrently with GLG 523. Cannot receive credit for both GLG 523 and GLG 623.

GLG 624 Coastal Marine Geology Lab. 1(0-2), Su. Prerequisite: concurrent enrollment in GLG 623. Laboratory portion of GLG 623. Field and laboratory activities. Must be taken at Gulf Coast Research Laboratory, Ocean Springs, Mississippi. May be taught concurrently with GLG 524. Cannot receive credit for both GLG 524 and GLG 624.

GLG 630 Optical Mineralogy. 3(1-4), D. Recommended Prerequisite: GLG 333. Essentials of optical crystallography; the use of the petrographic microscope in the identification of rock-forming minerals, both in oil-immersion grain mounts and in thin sections. May be taught concurrently with GLG 530. Cannot receive credit for both GLG 530 and GLG 630.

GLG 640 X-Ray Mineralogy. 3(1-4), D. Recommended Prerequisite: GLG 332. Principles and techniques of x-ray mineralogy; the use of x-ray powder diffraction in the identification and characterization of minerals and related crystalline phases. May be taught concurrently with GLG 540. Cannot receive credit for both GLG 540 and GLG 640.

GLG 670 Principles of Stratigraphy. 4(3-2), F. Recommended Prerequisite: GLG 314 and GLG 333. Principles underlying the deposition of sediments; environmental control of lithofacies and biofacies; recognition of ancient depositional environments by key indicators and modern analogs. May be taught concurrently with GLG 570. Cannot receive credit for both GLG 570 and GLG 670.

GLG 672 Geohydrology. 3(2-2), S. Recommended Prerequisite: GLG 314; and either MTH 261 or MTH 287. Aquifer properties; elementary theory of groundwater flow through a porous medium; well and aquifer relationships. Laboratories include ground-water case studies and Hydrologic Investigation Atlas interpretations. Field trips required. Taught concurrently with GLG 472. Cannot receive credit for both GLG 472 and GLG 672.

GLG 673 Engineering Geology. 3(2-2), SE. Recommended Prerequisite: GLG 333. Engineering properties of rocks and soils; fundamentals of engineering geology field investigations; application of properties and fundamentals to engineering problems concerning slope stability, groundwater, industrial contamination, urban public works, and karst areas. Laboratories include engineering classification of soils, hydraulic conductivity testing, and public works design and management. Field trip to observe engineering problems of karst required. May be taught concurrently with GLG 473. Cannot receive credit for both GLG 673 and GLG 473.

GLG 680 Geochemistry. 3(2-2), F. Recommended Prerequisite: GLG 332. Topics include the dominant chemical reactions in natural waters, equilibrium conditions between mineral precipitation and dissolution, and characteristics of contaminated groundwater. Field trips required. Taught concurrently with GLG 480. Cannot receive credit for both GLG 480 and GLG 680.

GLG 681 Geochemical Techniques. 4(2-4), SO. Recommended Prerequisite: GLG 332. Geochemical techniques and procedures used in ore exploration, point and nonpoint contamination and other environmental studies. Analyses of trace elements in rocks, soils, plants and waters using inductively coupled plasma methods. Also use of GPS to locate sample sites and Arcview to prepare maps. Field trips required. May be taught concurrently with GLG 581. Cannot receive credit for both GLG 581 and GLG 681.

GLG 690 Applied Geophysics. 3(2-2), S. Recommended Prerequisite: GLG 340; and either PHY 124 or PHY 204; and either MTH 280 or MTH 288. Application of geophysical methods in solving geologic problems. Techniques covered include seismic refraction and reflection, gravity, magnetics, direct current and electromagnetic resistivity. Field trips required. May be taught concurrently with GLG 590. Cannot receive credit for both GLG 590 and GLG 690.

GLG 697 Selected Topics in Geology. 1-5, D. Prerequisite: permission. Detailed treatment of various advanced topics in geology which may vary from year to year. Some typical topics: geologic instrumentation, selenology, sedimentology, and crystallography. Variable content course. May be repeated for a total of 6 hours. May be taught concurrently with GLG 597. Cannot receive credit for both GLG 597 and GLG 697.

GLG 701 Geology for Secondary Teachers I. 3(2-2), D. Prerequisite: permission. Earth materials, geological processes, geological history and the geological environments.

GLG 702 Geology for Secondary Teachers II. 3(2-2), D. Prerequisite: GLG 701. Continuation of GLG 701.

GLG 713 Field Geology for Secondary Teachers. 1-3, D. Prerequisite: permission. Field work; identification and correlation of rock units; determination of depositional environments from fossils and other indicators. Students are required to make a collection of specimens from rock formations in the study area. May be repeated to a total of 6 hours when destination varies. Supplemental course fee.

GLG 751 Seminar in Geology. 2(2-0), D. Prerequisite: permission. Preparation of an extensive paper on selected topics to be read before staff seminars.

GLG 765 Selected Topics in Earth Science. 1-3 D. Prerequisite: permission. Students cooperatively select from general subject areas in earth science more specific areas to explore. Topics are studied consecutively during the semester. Subject areas from which the topic selections are made are included in the class schedule for each term the course is offered. Variable content course. Since topics vary, the course may be repeated for a total of 6 hours. Identical to GRY 740. Cannot receive credit for more than 6 hours of GLG 755 and GRY 740 combined.

GLG 798 Research in the Geological Sciences. 1-3, D. 1-3, D. Prerequisite: permission. Original research supervised by the geology staff, involving special areas of the geological sciences. May be repeated to a total of 5 hours.

GLG 799 Thesis. 1-6, D. Prerequisite: permission. Independent research and study connected with preparation of thesis.

GEOGRAPHY COURSES

GRY 607 Geography of Subsaharan Africa. 3(3-0), D. An in-depth geographic study of Africa south of the Sahara Desert. Surveys physical and political geography, climate, tribalism, religion, demography, natural resources, transportation, industry and economic activities of African states South of the Sahara. Students are required to complete two research projects. May be taught concurrently with GRY 507. Cannot receive credit for both GRY 507 and GRY 607.

GRY 610 Tourism and Sustainability. 3(3-0), S. Recommended Prerequisite: GRY 301. Study of sustainability issues associated with tourism development. Attention paid to the conflicting agenda of society's various stakeholders and the need to reconcile environmental, economic, and sociocultural concerns. Emphasis also placed on policy implications. May be taught concurrently with GRY 510. Cannot receive credit for both GRY 510 and GRY 610.

GRY 625 Environmental Hazards. 3(3-0), S. Recommended Prerequisite: GRY 142; or both GRY 135 and GLG 110. Identification, recognition, and impact of hazards. Physical exposure to hazards and human vulnerability in LDCs and MDCs. Disaster trends and patterns. Behavioral and structural paradigms of hazards. EM-DAT: international disaster database. Statistical methods used in risk assessments. Risk perception, communication, and disaster management. Tectonic, mass movement, atmospheric, hydrological, biophysical, and technological hazards: analysis, preparedness, and mitigation. May be taught concurrently with GRY 525. Cannot receive credit for both GRY 525 and GRY 625.

GRY 635 Global Climate and Weather Cycles. 3(3-0), D. Recommended Prerequisite: GRY 135. Energy and mass exchanges. Global atmospheric circulation; surface and upper-air flows. Index cycle: zonal and meridional atmospheric circulations. Teleconnections and atmospheric oscillations: NAO, PNA, PDO, AO, ENSO, and AMO. Interactions between atmospheric oscillations and surface climatic variables in the United States and around the world. Weather cycles, natural climatic variability and climate change. Drought indices. Spatial and temporal statistical domains used in climatic data analysis. May be taught concurrently with GRY 535. Cannot receive credit for both GRY 535 and GRY 635.

GRY 645 Global Environmental Change. 3(2-2), D. Recommended Prerequisite: GRY 142 or both GRY 135 and GLG 110. Energy and mass fluxes and storages in the interlinked physical components of the ecosphere. Chemistry of the global atmosphere. Role of the oceans and thermohaline circulation. Land use and land cover influences on terrestrial ecosystems. Concepts of environmental cycles, thresholds, resilience, recovery and response times. Understanding past environmental changes. Causes, mechanisms and likely impacts of natural and anthropogenically-induced changes on the global environment. Predictive models on global environmental change. May be taught concurrently with GRY 545. Cannot receive credit for both GRY 545 and GRY 645.

GRY 650 Fluvial Geomorphology. 3(3-0), S. Study of the formation, composition, distribution of fluvial landforms. Emphasis is on channel hydrology, quantification of geomorphic relationships, reach and watershed-scale processes, sediment transport, water and sediment contamination, and management applications to streams in the Ozarks Region as well as other places. Field work may be required. May be taught concurrently with GRY 548. Cannot receive credit for both GRY 548 and GRY 650.

GRY 696 Topical Issues in Education. 1-5, D. Prerequisite: permission. Selected topics in geography and earth science to upgrade understandings and skills in improvement of elementary or secondary teaching. Each course is concerned with a single topic or subject matter area. Number of class hours determined by semester hours of credit. Variable content course. May be repeated to a total of 5 hours credit. Supplemental course fee assessed for section titled Stream Environments. May be taught concurrently with GRY 596. Cannot receive credit for both GRY 596 and GRY 696.

GRY 697 Special Topics in Geography. 1-5, D. Prerequisite: permission. Selected topics in geography. Special topics will be included in the class schedule for each term. Field trips may be required. Number of class hours determined by semester hours of credit. Variable content course. May be repeated to a maximum of 6 hours credit. May be taught concurrently with GRY 597. Cannot receive credit for both GRY 597 and GRY 697.

GRY 698 Research in Geography. 1-3, F,S. Prerequisite: permission. Enrichment through guided but independent, original research in geography and geography related subject areas. May be repeated for a total of 6 credit hours. May be taught concurrently with GRY 599. Cannot receive credit for both GRY 599 and GRY 698.

GRY 700 Cultural Geography for Secondary Teachers I. 3(2-2), D. Population and the spatial imprint of man on the landscape in terms of settlement, economic activities, institutions; methods and materials of the high school geography project; other current curriculum materials.

GRY 703 Cultural Geography for Secondary Teachers II. 3(2-2), D. Prerequisite: GRY 700. Continuation of GRY 700. Contemporary problems in land use, urbanization and planning for optimum use of resources; methods and materials of the high school geography project; other current curriculum materials.

GRY 730 Weather Elements for Secondary Teachers. 3(3-0), D. Physical processes of the earth's atmosphere, use of weather instruments and interpretation of weather maps. Applied aspects of weather and climate and their effects on man's activities. Emphasis on current curriculum materials for secondary schools.

GRY 731 Environmental Assessment. 3(2-2), S. The procedures and processes of environmental assessment. Soils, hydrology, climate, biogeography and geomorphology will be examined in an environmental assessment context. Environmental assessment is a prerequisite for satisfying the National Environmental Policy Act (NEPA) requirements.

GRY 740 Selected Topics in Earth Science. 1-3, D. Prerequisite: permission of instructor. Students cooperatively select from general subject areas in earth science more specific areas to explore. Topics are studied consecutively during the semester. Subject areas from which the topic selections will be made are included in the class schedule for each term the course is offered. Variable content course. Since topics vary, the course may be repeated for a total of 6 hours. Identical with GLG 765. Cannot receive credit for more than 6 hours of GRY 740 and GLG 765.

GRY 748 Physiography and Resource Conservation. 3(2-2), D. Landforms, economic minerals, soils, climate, water resources and closely related aspects of the natural environment as they relate to man's inhabitation and use of the earth; map reading and simple map construction; methods and materials for secondary schools.

GRY 751 Topics in Advanced Physical Geography. 3(3-0), D. Critical review of recent advances and trends in applied and/or theoretical physical geography. Course will involve the study of seminal and recent journal articles and presentation of a research paper. Course content may vary among the subfields of physical geography including geomorphology, hydrology, water resources, soil geography climatology, and biogeography. Field trips may be required.

GRY 799 Thesis. 1-6, F,S. Prerequisite: permission. Independent research and study connected with preparation of thesis.

GEOSPATIAL SCIENCE COURSES

GEO 651 Remote Sensing. 3(2-2), S. Recommended Prerequisite: GRY 360. Introduction to environmental studies through the application of remotely sensed imagery and geospatial technologies. The course covers principles of remote sensing, interactions of electromagnetic energy with the atmosphere and earth's surface, satellite systems and sensors (electro-optical, thermal, radar and lidar). Emphasis is placed on regional and global monitoring, land cover mapping, forestry, agriculture, geology, planning and oceanography. Laboratory emphasizes interpretation of remotely sensed imagery and introduction to digital image processing including enhancements, corrections and classification routines. May be taught concurrently with GEO 551. Cannot receive credit for both GEO 551 and GEO 651.

GEO 661 Intermediate Geographic Information Science. 3(2-2), S. Recommended Prerequisite: GRY 363. Principles and applications of Geographic Information Systems (GIS) software. Examines the nature and accuracy of spatially referenced data, as well as methods of data capture, storage, retrieval, visualization and output. May be taught concurrently with GEO 561. Cannot receive credit for both GEO 561 and GEO 661.

GEO 662 Internet Geospatial Science. 3(2-2), F. Recommended Prerequisite: GEO 561 or GEO 661. Basic understanding of the contemporary standards for using the Internet to distribute and utilize geospatial data. Students will develop and implement both single or multiple source geospatial portals. A major part of the course will examine user interaction design for geospatial data in both a wired and wireless environment. May be taught concurrently with GEO 562. Cannot receive credit for both GEO 562 and GEO 662.

GEO 666 Advanced Geographic Information Science. 3(2-2), F. Recommended Prerequisite: GEO 561 or GEO 661. A theoretical and practical examination of analytical methods use in GIS, including vector and raster models, spatial overlay, incorporation of field data, analysis of surfaces, interpolation, TINs and network analysis. May be taught concurrently with GEO 566. Cannot receive credit for both GEO 566 and GEO 666.

GEO 668 Thematic Cartography. 3(2-2), D. Recommended Prerequisite: GEO 561 or GEO 661. Theoretical and applied aspects of map design in thematic mapping, animated mapping, interactive and web mapping. Emphasis will be applying computer-assisted mapping techniques of the problems of effective and efficient communication of spatial data. Field trip is required. May be taught concurrently with GEO 570. Cannot receive credit for both GEO 570 and GEO 668.

GEO 672 Introduction to Photogrammetry and Spatial Statistics. 3(1-4), S. Recommended Prerequisite: GRY 360. Course covers basic concepts of photogrammetry and spatial statistics such as stereo feature extraction, orthophoto, point pattern recognition and kriging. Laboratory emphasizes geospatial stereo feature extraction using digital photogrammetry software and ArcGIS spatial statistics toolbox. May be taught concurrently with GEO 572. Cannot receive credit for both GEO 572 and GEO 672.

GEO 673 Geographic Information Science Programming. 3(2-2), S. Recommended Prerequisite: GEO 561 or GEO 661, and either CIS 202 or CSC 121 or CSC 125. Course devoted to theories and processes of analytical and automated Geographic Information Science (GIS). Principal topics covered are spatial programming, geographic data storage, computer map rendering, application customization and automation and human interface development of GIS. Advanced GIS and programming skills for professional development are emphasized. May be taught concurrently with GEO 573. Cannot receive credit for both GEO 573 and GEO 673.

GEO 675 Satellite-Based Surveying and Mapping. 3(1-4), S. Theory and operation of global positioning systems (GPS) hardware and software. Including mission planning, measurement of point, line and area features, differential correction techniques and waypoint navigation. Field exercises required. May be taught concurrently with GEO 575. Cannot receive credit for both GEO 575 and GEO 675.

GEO 678 Remote Sensing Digital Image Processing. 3(2-2), F. Prerequisite: GEO 551 or GEO 651 or GEO 566 or GEO 666 or GEO 572 or GEO 672. Advanced application of remote sensing digital image processing in areas of interest such as land use/land cover mapping, agriculture, forestry, resource planning and geology. Course covers image visualization, image correction, classification algorithms and change detection methods. Laboratory emphasizes advanced image processing techniques using ENVI software. May be taught concurrently with GEO 578. Cannot receive credit for both GEO 578 and GEO 678.

GEO 700 Introduction to Graduate Study in Geospatial Science. 3(3-0), F. Orientation to graduate study in geospatial sciences and development of a research proposal.

GEO 701 Research Methods in Geospatial Science. 3(2-2), S. Prerequisite: GEO 700. Methods of collecting, organization, and analyzing data pertinent to graduate study in Geospatial Science. Emphasis will be on the application of univariate and multivariate statistical techniques and other quantitative techniques pertinent to mathematically and statistically modeling geospatial problems.

GEO 755 Applications of Digital Cartography, Analytical Photogrammetry, and Remote Sensing. 1-3, D. Prerequisite: permission. Advanced application of aerial photography and digital imagery, analytical photogrammetry, remote sensing, digital cartography and other geospatial technologies in areas of interest such as land use/land cover mapping, landscape ecology, agriculture, forestry, resource planning, geology, and soils. Since credit and topics vary, the course may be repeated for a maximum of 7 hours with permission.

GEO 770 Advanced Field and Laboratory Methods. 3(1-4), D. Advanced training in laboratory and field methods in geography and geology. Topics will vary due to faculty expertise or student interest. Examples include watershed monitoring techniques, geochemical techniques, and field studies in remote areas. Field trips are required.

GEO 780 Research Paper in Geospatial Sciences. 1-3, D. Prerequisite: permission. Extensive research paper on selected topic to be presented before staff seminars. Exclusively satisfies requirements for non-thesis option, which requires the completion of two research papers, with at least one research paper presented orally as a departmental seminar. May be repeated once to total 3 hours.

PLANNING COURSES

PLN 605 Social Planning. 3(3-0), S. This course will address planning issues as they relate to social policy and the provision of social welfare. The first part of the course will introduce principles that guide the development of social planning, including fairness and justice; and a macro overview of programs that deal with the fundamental service of societal problems, and poverty. The second part of this course will examine various social policy controversies such as low-income housing, homelessness, community revitalization, and the service-dependent poor. A field project is required. May be taught concurrently with PLN 405. Cannot receive credit for both PLN 405 and PLN 605.

PLN 670 Planning Law. 3(3-0), S. Study of the legal foundations of land use controls. Topics include historic legal cases establishing government intervention in private development zoning, subdivision, growth management, individual liberty, environmental regulation and the general welfare concept. May be taught concurrently with PLN 470. Cannot receive credit for both PLN 470 and PLN 670.

PLN 671 Land Use Planning. 3(3-0), F. Recommended Prerequisite: PLN 271 or PLN 372 or RIL 266. Focuses on conceptual and analytical techniques of land use planning, including land use analysis, planning studies and procedures, and synthesis of planning elements through comprehensive plan development. May be taught concurrently with PLN 471. Cannot receive credit for both PLN 471 and PLN 671.

PLN 672 Community Planning Practicum. 4(3-2), S. Prerequisite: PLN 471 or PLN 671. Focuses on the process of plan preparation and is intended to provide experience in the application of planning principles and analytical techniques learned in other program courses to an actual planning problem. Students will work on an individual basis and as part of a team in preparing a final report. Field problems will vary. May be taught concurrently with PLN 472. Cannot receive credit for both PLN 472 and PLN 672.

PLN 673 Urban Design and Preservation. 3(3-0), S. Recommended Prerequisite: PLN 271 and GRY 322. Elements of urban design and preservation in relation to social, economic, and political forces; the role of the urban designer in the planning process. May be taught concurrently with PLN 573. Cannot receive credit for both PLN 573 and PLN 673.

PLN 674 Open Space and Recreation Planning. 3(2-2), S. Content focuses on planning and design for parks, both active and passive recreation, and other open space amenities. Open space and recreation planning will be integrated with land use, economic, social, and transportation considerations involved in community and regional planning. Field problem required. May be taught concurrently with PLN 574. Cannot receive credit for both PLN 574 and PLN 674.

PLN 676 Site Planning Studio. 4(2-4), F. Recommended Prerequisite: PLN 271 and PLN 372. Lecture-studio focusing on the principles and processes of urban design and site specific design requirements. Students will design site plans for specific uses such as subdivisions, shopping centers and parks for public presentation. May be taught concurrently with PLN 576. Cannot receive credit for both PLN 576 and PLN 676.

PLN 696 Research in Planning. 1-3, F,S. Prerequisite: permission. Enrichment through guided but independent, original research in planning and planning related subject areas. May be repeated to a total of 6 credit hours. May be taught concurrently with PLN 596. Cannot receive credit for both PLN 596 and PLN 696.

PLN 697 Selected Topics in Planning. 1-5, D. Detailed treatment of various advanced topics in planning which may vary from semester to semester. Some typical topics: Economic Development Planning, Rural and Small Town Planning, Housing in America. Variable content course. May be repeated to a total of 6 hours. May be taught concurrently with PLN 597. Cannot receive credit for both PLN 597 and PLN 697.

PLN 699 Internship in Urban and Regional Planning. 1-3, F,S. Recommended Prerequisite: PLN 471. Work in community or regional planning agency. Students are monitored by Planning faculty and supervisory personnel of the planning agency. May be repeated to a total of 6 hours. May be taught concurrently with PLN 599. Cannot receive credit for both PLN 599 and PLN 699.

PLN 704 Community Resource Planning. 1-3, D. Explanation of community growth and change. Review of public and private agency programs. Topics may focus on small towns and rural areas as well as urban and metropolitan areas. Since credit and topics vary, the course may be repeated for a maximum of 7 hours with permission.

DEPARTMENT OF MATHEMATICS

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GRADUATE FACULTY

Distinguished Professor: Paula A. Kemp
Professor: Richard G. Belshoff, Larry N. Campbell, Yungchen Cheng, Kanghui Guo, Shouchuan Hu, J. Kurt Killion, Shelby J. Kilmer, John D. Kubicek, George Mathew, Lynda S. Plymate, Les Reid, Kishor Shah, Clayton C. Sherman, Vera B. Stanojevic, Yingcai Su, Xingping Sun, Cameron Wickham, Xiang Ming Yu, Liang-Cheng Zhang
Associate Professor: David I. Ashley, Gay A. Ragan, Jorge Rebaza, Mark W. Rogers
Emeritus Professor: Earl E. Bilyeu, James R. Downing, Frank S. Gillespie, Shirley M. Huffman, David B. Lehmann, E. Rebecca Matthews, Neil C. Pamperien, Clyde A. Paul, Woodrow Sun, William Sutherlin, Joe L. Wise

MASTER OF SCIENCE, MATHEMATICS

ENTRANCE REQUIREMENTS

Students seeking admission to the Master of Science program in mathematics must meet the general Graduate College requirements for admission as degree-seeking students. In addition, students must have the following.

1. Students must have credit for MTH 503 Advanced Calculus; MTH 532 Abstract Algebra; MTH 533 Linear Algebra; MTH 540 Statistical Theory I, or equivalent courses.

2. Students must have a GPA, in upper division mathematics courses beyond the first calculus sequence, of 3.00 or higher on a 4.00 scale.

Students who do not meet conditions 1 and 2 above may be admitted conditionally. Deficiencies must be made up with B grades or above in courses approved by the mathematics department. Credit in such courses will not count toward the total hours required for the Master of Science in mathematics.

DEGREE REQUIREMENTS (A minimum of 32 hrs)

1. A minimum of 18 semester hours of 700 level mathematics courses. At least one of the following four courses must be completed:

   MTH 702 Real and Abstract Analysis
   MTH 732 Abstract Algebra II
   MTH 722 Theory of Ord. Differential Equat. II
   MTH 742 Statistical Inference II

   Students planning to continue to a Ph.D. degree are strongly advised to take the analysis and algebra sequences.

2. **Mathematics Electives**. From 4 to 15 elective hours in mathematics, dependent upon hours of research and other electives.

3. **Related Electives**. A maximum of 6 hours of elective courses in fields related to mathematics may be taken with the approval of the student's advisor.

4. **Research Requirements.** 1-6 semester hours of course work from MTH 791, 792, 798, or 799, but a maximum of 6 semester hours may be applied toward the requirement for the M.S. degree. This requirement will be met in one of the following ways:

   Option I: Completion of a satisfactory thesis in the candidate's discipline. Thesis credit shall be no more than 6 semester hours of the minimum 32 hours required for a master's degree.

   Option II: Completion of a minimum of two seminars, each of which shall require an extensive paper or major creative work.

5. **Comprehensive Examination.** A comprehensive examination must be passed by the candidate before a degree will be granted.

ACCELERATED MASTER'S OPTION

The Accelerated Master's Program option in Mathematics provides an opportunity for outstanding undergraduate students to begin their graduate course work during their senior year. To be eligible to apply for admission to this program, the student must have completed at least three of the courses MTH 503, MTH 532, MTH 533 and MTH 540; have a GPA of 3.5 or higher in all mathematics courses numbered MTH 261 or higher. An eligible student may apply for admission during the second semester of the junior year.

If accepted into the accelerated program, up to a maximum of 6 hours of 600/700 level mathematics courses taken after admission into the program may be given credit for both undergraduate and graduate programs. The courses MTH 603, MTH 631, MTH 633, and MTH 640 will not be given credit in the graduate program. A student is fully admitted to the Graduate College upon completion of the requirements for the baccalaureate degree. All requirements for the master's program should be met for graduation from the master's program.

Before enrolling in a course to be counted as both undergraduate and graduate credit and to count the course toward the masters degree, an undergraduate student must be accepted into the accelerated program and receive prior approval from the graduate program advisor, department head of the undergraduate program, and the dean of the Graduate college. Acceptance into the program and all approvals must be completed prior to the end of the Change of Schedule Period for the course(s). See the Graduate College for further information.

MASTER OF NATURAL AND APPLIED SCIENCE

See separate program listing under the College of Natural and Applied Sciences. (Accelerated masters opportunity available.)

MASTER OF SCIENCE IN EDUCATION, SECONDARY EDUCATION: MATHEMATICS AREA OF EMPHASIS

Contact Dr. Lynda Plymate and refer to the program requirements for the M.S.Ed., Secondary Education under Interdisciplinary Graduate Programs, page 61.

PREREQUISITE MATHEMATICS REQUIREMENTS

MTH 315 or equivalent; and MTH 302 or equivalent.

MATHEMATICS REQUIREMENTS Total 15 hrs

Mathematics courses selected with a minimum of 3 hours in courses numbered 700 or above.

MASTER OF SCIENCE IN EDUCATION, SECONDARY EDUCATION: NATURAL SCIENCE AREA OF EMPHASIS

Contact Dr. Tamera Jahnke and see program requirements for the M.S.Ed., Secondary Education under Interdisciplinary Graduate Programs, page 61.

NATURAL SCIENCE PREREQUISITE AND REQUIREMENTS

In this option, students complete a minimum of 15 hours with course work selected from two of the following disciplines: Biology, Chemistry, Geography and/or Geology, Mathematics, and Physics. A minimum of 3 hours of course work numbered 700 or above must be included. The prerequisite requirements are those listed in the departmental statements of both selected academic areas of emphasis.

Courses from one of the above disciplines	9 hrs
Courses from a second of the above disciplines	6 hrs
	Total 15 hrs

MATHEMATICS COURSES

MTH 603 Advanced Calculus I. 3(3-0), F,S. Prerequisite: MTH 280 and MTH 315. Concepts of limit, continuity, differentiation, Riemann integration, sequences and series, other related topics. May be taught concurrently with MTH 503. Cannot receive credit for both MTH 503 and MTH 603.

MTH 604 Advanced Calculus II. 3(3-0), D. Prerequisite: MTH 302; and MTH 503 or MTH 603. This is a continuation of MTH 603, including sequences and series of functions, uniform convergence, multivariate calculus, and other selected topics. May be taught concurrently with MTH 504. Cannot receive credit for both MTH 504 and MTH 604.

MTH 605 Theory of Functions of a Complex Variable. 3(3-0), D. Prerequisite: MTH 280 and MTH 315. Theory of elementary functions-polynomial, trigonometric, exponential, hyperbolic, logarithmic-of a complex variable; their derivatives, integrals; power series; other selected topics. May be taught concurrently with MTH 506. Cannot receive credit for both MTH 506 and MTH 605.

MTH 607 Introduction to Partial Differential Equations. 3(3-0), D. Prerequisite: MTH 302 and MTH 303 and MTH 315. Introduction to linear first and second order partial differential equations, including some formal methods of finding general solutions; the Cauchy problem for such equations, existence theorems, formal methods of finding the solution, and the role of characteristics; the classical boundary and initial value problems for the wave equation, heat equation and the boundary value problems for Laplace's equation. May be taught concurrently with MTH 507. Cannot receive credit for both MTH 507 and MTH 607.

MTH 631 Introduction to Abstract Algebra. 3 (3-0), F. Prerequisite: MTH 302 and MTH 315. Theory of groups, rings, integral domains, fields, polynomials. May be taught concurrently with MTH 532. Cannot receive credit for both MTH 532 and MTH 631.

MTH 633 Linear Algebra I. 3(3-0), F,S. Prerequisite: MTH 280 and MTH 315. Vector spaces, linear independence, inner product spaces, linear transformations, Eigenvectors, diagonalization. May be taught concurrently with MTH 533. Cannot receive credit for both MTH 533 and MTH 633.

MTH 634 Linear Algebra II. 3 (3-0), D. Prerequisite: MTH 533 or MTH 633. Topics include eigenvalue problems; Jordan normal form, linear functionals, bilinear forms, quadratic forms, orthogonal and unitary transformations, Markov processes, and other topics selected by the instructor. May be taught concurrently with MTH 534. Cannot receive credit for both MTH 534 and MTH 634.

MTH 636 Theory of Numbers. 3(3-0), D. Prerequisite: MTH 302 and MTH 315. Factorization, Euler totient function, congruences, primitive roots, quadratic residues and reciprocity law. May be taught concurrently with MTH 536. Cannot receive credit for both MTH 536 and MTH 636.

MTH 637 Applied Abstract Algebra. 3 (3-0), D. Prerequisite: MTH 532 or MTH 632 or MTH 533 or MTH 633. Topics typically include finite fields, block designs, error-correcting codes (nonlinear, linear, cyclic, BCH, and Reed-Solomon codes), cryptography, and computer implementation of these applications. May be taught concurrently with MTH 537. Cannot receive credit for both MTH 537 and MTH 637.

MTH 640 Statistical Theory I. 3(3-0), F. Prerequisite: MTH 302 and MTH 315. Random variables, discrete and continuous probability functions, expectation, moment-generating functions, transformation of variables. May be taught concurrently with MTH 540. Cannot receive credit for both MTH 540 and MTH 640.

MTH 643 Statistical Theory II. 3(3-0), S. Prerequisite: MTH 540 or MTH 640 or equivalent. Estimation, complete and sufficient statistics, maximum likelihood estimation, hypothesis testing, nonparametric statistics. May be taught concurrently with MTH 541. Cannot receive credit for both MTH 541 and MTH 643.

MTH 645 Applied Statistics. 3(3-0), F. A course on statistical concepts, methods and data analysis with emphasis on assumptions and effects on violating those assumptions. Computer statistical packages will be used. Topics include statistical models, random sampling, normal distribution, estimation, confidence intervals, tests and inferences in single and two populations, and n-way analysis of variance. May be taught concurrently with MTH 545. Cannot receive credit for both MTH 545 and MTH 645.

MTH 646 Analysis of Variance and Design of Experiments. 3(3-0), D. Prerequisite: MTH 345 or MTH 541 or MTH 643 or MTH 545 or MTH 645. Topics include analysis of variance, estimation of variance components, randomized incomplete blocks, Latin squares, factorial nested, split-plot designs, fixed, random and mixed models. May be taught concurrently with MTH 546. Cannot receive credit for both MTH 546 and MTH 646.

MTH 647 Applied Regression Analysis. 3(3-0), D. Prerequisite: MTH 345 or MTH 541 or MTH 643 or MTH 545 or MTH 645. Topics include fitting a straight line, matrix models, residuals, selecting best equation, multiple regression, and nonlinear estimation. May be taught concurrently with MTH 547. Cannot receive credit for both MTH 547 and MTH 647.

MTH 648 Applied Time Series Analysis. 3(3-0), F. Prerequisite: MTH 540 or MTH 640; and MTH 345 or MTH 541 or MTH 643 or MTH 545 or MTH 645. This course will study the analysis of data observed at different points of time. Topics include stationary and non-stationary time series models, linear time series models, autoregressive models, autocorrelations, partial autocorrelations, moving average models, ARMA models, ARIMA models, forecasting, prediction limits, model specification, least square estimation, and seasonal time series models. Computer statistical packages will be used. May be taught concurrently with MTH 548. Cannot receive credit for both MTH 548 and MTH 648.

MTH 653 Stochastic Modeling. 3(3-0), S. Prerequisite: MTH 540 or MTH 640. This course will study applications of probability and statistics from a modeling point of view. Topics include generating functions, branching processes, discrete time Markov chains, classification of states, estimation of transition probabilities, continuous time Markov Chains, Poisson processes, birth and death processes, renewal theory, queuing systems, Brownian motion, and stationary processes. Computer statistical packages will be used. May be taught concurrently with MTH 543. Cannot receive credit for both MTH 543 and MTH 653.

MTH 667 Introduction to Non-Euclidean Geometry. 3(3-0), S. Prerequisite: MTH 302 and MTH 315. Development of non-Euclidean geometries; intensive study of hyperbolic geometry. May be taught concurrently with MTH 567. Cannot receive credit for both MTH 567 and MTH 667.

MTH 670 Combinatorial Analysis. 3(3-0), D. Prerequisite: MTH 280 and MTH 315. An introduction to combinatorial analysis including enumeration methods, combinatorial identities with applications to the calculus of finite differences and difference equations. May be taught concurrently with MTH 570. Cannot receive credit for both MTH 570 and MTH 670.

MTH 675 History of Mathematics. 3(3-0), F, S. Prerequisite: MTH 302 and MTH 315. Development of mathematics through the calculus; solution of problems of historical interest, problems which use historically significant techniques; problems whose solutions illuminate significant mathematical characteristics of elementary mathematics. May be taught concurrently with MTH 575. Cannot receive credit for both MTH 575 and MTH 675.

MTH 680 Applied Mathematics. 3(3-0), D. Prerequisite: MTH 303; and MTH 533 or MTH 633. An introduction to several areas of applied mathematics including control theory, optimization, modeling of population dynamics, modeling of mathematical economics, minimax and game theory, and calculus of variations. May be taught concurrently with MTH 580. Cannot receive credit for both MTH 580 and MTH 680.

MTH 682 Introductory Topology. 3(3-0), D. Prerequisite: MTH 302 and MTH 315. Properties of abstract metric and topological spaces; discussion of concepts of compactness and connectedness. May be taught concurrently with MTH 582. Cannot receive credit for both MTH 582 and MTH 682.

MTH 696 Readings. 1-3, F,S. Prerequisite: permission of department head. Periodic conferences with an advisor are required. May be repeated to a total of 6 hours. May be taught concurrently with MTH 596. Cannot receive credit for both MTH 596 and MTH 696.

MTH 701 Real Analysis. 3(3-0), D. Prerequisite: MTH 503 or MTH 603. Topics include countable and uncountable sets, convergence, Lebesgue measure on the real line, the development of the Lebesgue integral, the fundamental theorem of calculus and Lp spaces.

MTH 702 Real and Abstract Analysis. 3(3-0), D. Prerequisite: MTH 701. A study of the theory of abstract measures and integration, and an introduction to functional analysis.

MTH 706 Complex Analysis. 3 (3-0), D. Prerequisite: MTH 503 or MTH 603. Analytic functions, power series, Cauchy's theorem and its applications, residues. Selected topics from conformal mapping, analytic continuation, harmonic functions, Fourier series, and Dirichlet problems.

MTH 710 Contemporary Mathematics for Secondary Teachers.

3(3-0), D. Prerequisite: MTH 460; and MTH 533 or MTH 633. Reports, research, and recent trends in secondary mathematics; recently developed programs in algebra and geometry.

MTH 721 Theory of Ordinary Differential Equations I. 3(3-0), D. Prerequisite: MTH 303; and MTH 503 or MTH 603. Existence and uniqueness theorems for first order differential equations; system of linear and nonlinear differential equations; continuous dependence of solutions on initial conditions and parameters; behavior of solutions of equations with constant coefficients, study of Lyapunov's theorems on stability; introduction to boundary value problems.

MTH 722 Theory of Ordinary Differential Equations II. 3(3-0), D. Prerequisite: MTH 721. Theory and application of boundary value problems; periodic solutions; linear systems with periodic coefficients (Floquet theory); two dimensional (autonomous) systems limit cycles. Differential equations under Caratheodory conditions; theory of differential and integral inequalities and other selected topics, if time permits.

MTH 730 Abstract Algebra I. 3(3-0), D. Prerequisite: MTH 532 or MTH 631; and MTH 533 or MTH 633. Topics from group theory will include Cayley's Theorem, finite abelian groups, Cauchy's Theorem, the Sylow Theorems, and free groups.

MTH 732 Abstract Algebra II. 3(3-0), D. Prerequisite: MTH 730. Topics from ring theory will include the Chinese Remainder Theorem, Euclidean domains, rings of fractions, PID's and UFD's, and polynomial rings. Topics from field theory will include splitting fields, Galois Theory, separability, normality, and finite fields.

MTH 741 Statistical Inference I. 3(3-0), D. Prerequisite: MTH 540 or MTH 640 or equivalent. Formulation of statistical models, sufficiency and exponential families, methods of estimation, optimality theory. Uniformly minimum variance unbiased estimators, Fisher information, Cramer/Rao inequality, large sample theory, Bayes procedures and minimax procedures.

MTH 742 Statistical Inference II. 3(3-0), D. Prerequisite: MTH 741. Confidence intervals and regions, hypothesis testing, the Neyman-Pearson framework, uniformly most powerful tests, likelihood ratio criteria, power functions, similar regions, invariant tests, distribution free tests.

MTH 781 Topology. 3(3-0), D. Point set topology in abstract spaces.

MTH 791 Seminar I. 2(2-0), F, S. Seminar in Mathematics.

MTH 792 Seminar II. 2(2-0), F, S. Seminar in Mathematics.

MTH 797 Topics. 3(3-0), D. Prerequisite: permission of department head. Material covered determined by the interests and backgrounds of the students. May be repeated for a maximum of 6 hours.

MTH 798 Research. 1-6, F, S. Supervised research in special areas of mathematics. May be repeated. May not be counted toward the Master of Science in Education degree.

MTH 799 Projects. 1-6, F, S. Independent research for thesis preparation.

DEPARTMENT OF PHYSICS, ASTRONOMY, AND MATERIALS SCIENCE

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GRADUATE FACULTY

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Associate Professor: Kartik C. Ghosh, Saibal Mitra, Michael D. Reed
Assistant Professor: Lifeng Dong
Research Professor (CASE): A. Steven Younger
Emeritus Professor: Lawrence E. Banks, Jr., Bruno Schmidt, George W. Wolf

MASTER OF SCIENCE, MATERIALS SCIENCE

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PROGRAM DESCRIPTION

The Materials Science degree is designed to provide the graduate with a suitable background for employment in the exciting field of electronic materials. Specifically, students will receive experience in high-technology materials synthesis and characterization, including the operation and design of the equipment used to make integrated circuits.

This degree was designed for students with good experimental skills, but little practical knowledge of specific instrumentation. Graduates will be prepared for employment in areas of semiconductor manufacturing, materials synthesis and testing, and other industries where high technology processing and development are required.

The program requires 9-12 hours of course work, 9 hours of laboratory course work, 6 hours of electives, 9-12 hours of thesis research and 1 hour of seminar, for a total of 37 hours. Interdisciplinary courses taught in other departments may be used for electives if approved by the department head in advance.

At the beginning of the first semester, students' background will be evaluated to determine the student's optimum path of study. Based on the results of the students' initial evaluation, poorly prepared students may be required to take some additional course work that will not apply to the degree. Later in the first semester, the student will interview with faculty members to choose an area of thesis research.

A comprehensive examination is required usually one semester prior to graduation. The comprehensive examination is used to monitor the progress of each student through the program. At the end of the thesis project, the student will present his or her results in the form of a public thesis presentation or defense.

ENTRANCE REQUIREMENTS

Students admitted to the program in full standing must meet the following requirements.

1. A Bachelor of Science degree in any science or engineering discipline which includes:
   a. a calculus sequence and differential equations;
   b. a calculus-based physics sequence; and
   c. two semesters of physical chemistry or thermodynamics and modern physics.

   For example, the following would constitute adequate preparation:

MTH 261	Analytical Geometry and Calculus I
MTH 280	Analytical Geometry and Calculus II
MTH 303	Differential Equations
PHY 203	Foundations of Physics I
PHY 204	Foundations of Physics II
PHY 343	Thermodynamics **OR**
CHM 506	Physical Chemistry I
PHY 375	Modern Physics **OR**
CHM 507	Physical Chemistry II

   Applicants with some deficiency in the courses listed in (1) above, may be admitted, but may have additional course work added to their program. This additional course work may not count toward their graduate degree.

2. Candidates for admission to the program are required to have a GPA of at least 3.00 on a 4.00 scale on the last 60 hours of course work.

3. Submission of Graduate Record Examination (GRE) scores from the General Test is required.

4. Three letters of reference.

Students who do not meet the GPA or GRE standards described in (3) and (4) above may be granted conditional admission to the program. Conditionally admitted students will be required to complete a minimum of nine hours of specified course work with a GPA of at least 3.00 to be advanced to full standing in the program.

RETENTION REQUIREMENTS

The student is expected to demonstrate effective communication skills while enrolled in the program. Evaluation of communication skills will be done in accordance with the student's background. These abilities will be evaluated for graduate assistants based on their teaching performance and by the MAT 798 Seminar course.

For students who are not graduate assistants, evaluation will be done in the MAT 798 Seminar course. For the student who uses English as a second language, there may be additional requirements.

The student must also demonstrate progress toward graduation in the following ways:

1. satisfactory performance in the comprehensive exam given approximately one semester before graduation
2. maintenance of a 3.00 GPA in the core courses
3. satisfactory progress in thesis research

DEGREE REQUIREMENTS (minimum of 37 hours)

1. For the student who has not received a "C" or better in a quantum mechanics course or its equivalent prior to admission to the program, satisfactory completion of PHY 675 Introduction to Quantum Mechanics is required.

2. Required core:
   MAT 640 Thermodynamics of Materials
   MAT 651 Introduction to Materials Science
   MAT 681 Structure of Solids
   MAT 750 Experimental Design
   MAT 760 Experiments in Physical Characterization
   MAT 770 Vapor Synthesis of Materials

3. Six hours, with at least 3 hours at the 700 level or above, chosen from the following:
   PHY 643 Kinetic Theory and Statistical Mechanics
   PHY 653 Electromagnetic Field Theory
   MAT 720 Advanced Quantum Mechanics
   MAT 758 Optoelectronic Materials
   MAT 780 Polymer Preparation & Characterization
   MAT 790 Statistical App. in Materials Science

   Interdisciplinary Courses approved by the department head for elective credit. Examples: BMS 614, Scanning Electron Microscopy or CHM 614 Polymer Chemistry

4. Seminar. 1 hour of seminar, MAT 798.

5. Research. 9-12 hours of research, MAT 799 (up to 6 hours must be thesis research - see #6 Thesis Research).

6. Thesis Research. Satisfactory completion of an approved thesis and an oral thesis defense to the student's faculty advisor and a committee of graduate faculty is also required.

7. Comprehensive Examinations. A passing grade on the comprehensive examination, taken approximately one semester before graduation.

ACCELERATED MASTER'S OPTION

Undergraduate Physics or Engineering Physics majors may wish to enroll in the Accelerated Master of Science degree program in Materials Science. Students who successfully complete this program can obtain an Engineering Physics Bachelor of Science degree and a Master of Science in Materials Science degree within five years.

This challenging option is for students who have a strong interest in becoming experts in electronic materials. This includes the fields of Solid State Physics, Photonics, Opto-electronics, Electrical Engineering, and computer Engineering.

While not essential for eventual admission to the program, it is strongly recommended that, as freshmen, students contact the department head for permission to become involved in the program. This will allow for appropriate advisement during the undergraduate years.

Students may be admitted to the program after completing 60 hours with a 3.00 cumulative GPA, including the engineering physics core courses with a 3.50 cumulative GPA.

Students seeking this option must:

1. Obtain admission to the Master of Science in Materials Science accelerated program by applying to the Graduate College prior to their senior year.
2. Pass the Master of Science in Materials Science comprehensive examination in the second semester of their senior year.

Before enrolling in a course to be counted as both undergraduate and graduate credit and to count the courses towards the masters degree, an undergraduate student must be accepted into the accelerated program and receive prior approval from the graduate program advisor, department head of the undergraduate program, and the dean of the Graduate College. Acceptance into the program and all approvals must be completed prior to the end of the Change of Schedule Period for the course(s). See the Graduate College for further information.

Nine hours of course work may be counted toward both the undergraduate and the masters degree. These courses are MAT 640, MAT 651 and MAT 681.

Students who successfully meet all the requirements would receive a Bachelor of Science degree in Engineering Physics at the end of their fourth year, and a Master of Science at the end of their fifth year.

MASTER OF NATURAL AND APPLIED SCIENCE

See program description listed in the Graduate College section under Interdisciplinary Programs. (Accelerated masters opportunity available.)

MASTER OF SCIENCE IN EDUCATION, SECONDARY EDUCATION: PHYSICS AREA OF EMPHASIS

Contact Dr. Bill Thomas and see program requirements for the M.S.Ed., Secondary Education under Interdisciplinary Graduate Programs, page 61.

PHYSICS REQUIREMENTS

Physics course work with a minimum of
3 hours in courses numbered 100 or above. **Total 15 hrs**

MASTER OF SCIENCE IN EDUCATION, SECONDARY EDUCATION: NATURAL SCIENCE AREA OF EMPHASIS

Contact Dr. Tamera Jahnke and see program requirements for the M.S.Ed., Secondary Education under Interdisciplinary Graduate Programs, page 61.

NATURAL SCIENCE PREREQUISITE AND REQUIREMENTS

In this option, students complete a minimum of 15 hours with course work selected from two of the following disciplines: Biology, Chemistry, Geography and/or Geology, Mathematics, and Physics. A minimum of 3 hours of course work numbered 700 or above must be included. The prerequisite requirements are those listed in the departmental statements of both selected academic areas of emphasis.

Courses from one of the above disciplines	9 hrs
Courses from a second of the above disciplines	6 hrs
	Total 15 hrs

ASTRONOMY COURSES

AST 613 Solar and Extra-Solar Systems. 3(3-0), FO. Prerequisite: AST 114 or AST 115; and MTH 303. Formation of planetary systems, planetary dynamics, and comparative planetology. Project required. Cannot receive credit for both AST 313 and AST 613. May be taught concurrently with AST 513. Cannot receive credit for both AST 513 and AST 613.

AST 615 Stellar Structure and Evolution. 3(3-0), SO. Prerequisite: AST 114 or AST 115; and MTH 303. Basic concepts of stellar structure, atmospheres, and evolution. Project required. Cannot receive credit for both AST 315 and AST 615. May be taught concurrently with AST 515. Cannot receive credit for both AST 515 and AST 615.

AST 617 Galaxies and Cosmology. 3(3-0), SE. Prerequisite: AST 114 or AST115; and MTH 303. Study of galaxies and the Universe. Topics include the structure and content of our Galaxy and other galaxies, clusters of galaxies, the Big Bang theory (including Inflation), and the eventual fate of our Universe. Project required. Cannot receive credit for both AST 317 and AST 617. May be taught concurrently with AST 517. Cannot receive credit for both AST 517 and AST 617.

AST 711 Astronomy for Teachers. 3(2-2) D. Theory and techniques of observational astronomy.

PHYSICS COURSES

PHY 602 Physics and Astronomy By Inquiry. 2(1-2), F. Prerequisite: PHY 101. This course is a continuation of PHY 101. Additional topics in mechanics, optics, heat, electricity and magnetism will be covered. The course will also include an introduction to Astronomy. Concepts will be explored using the inquiry approach. Will not count towards a major or minor in physics. May be taught concurrently with PHY 501. Cannot receive credit for both PHY 501 and PHY 602.

PHY 609 Special Topics in Physics and Astronomy. 1-3 D. Prerequisite: permission. Variable content, variable credit course. Topics to be chosen from current areas of interest. May be repeated to a total of 6 hours with different topic. May be taught concurrently with PHY 509. Cannot receive credit for both PHY 609 and PHY 509.

PHY 624 Digital Signal Processing. 4(2-4), S. Prerequisite: PHY 324 and PHY 354. Development of real-time digital signal processing systems using a DSP microprocessor, with an introduction to discrete-time signals and systems, discrete Fourier transforms, and digital filter designs. May be taught concurrently with PHY 524. Cannot receive credit for both PHY 524 and PHY 624.

PHY 633 Advanced Mechanics. 3(3-0), D Prerequisite: PHY 333. Advanced treatment of the dynamics of particles, rigid bodies, and continuous media. Topics include moving coordinate systems, rigid body motion, mechanics of continuous media, and theory of small vibrations. May be taught concurrently with PHY 533. Cannot receive credit for both PHY 533 and PHY 633.

PHY 643 Kinetic Theory and Statistical Mechanics. 3(3-0), D. Prerequisite: PHY 343 and PHY 375 and PHY 391. An introduction to statistical theories of physical systems containing large numbers of particles. Topics include the microcanonical, canonical, and grand canonical ensembles, the connection of statistical physics to thermodynamics, Boltzmann statistics, Bose-Einstein statistics, Fermi-Dirac statistics, and applications. May be taught concurrently with PHY 543. Cannot receive credit for both PHY 543 and PHY 643.

PHY 653 Electromagnetic Field Theory. 3(3-0), D. Prerequisite: PHY 353. Mathematical treatment of electric and magnetic fields in a vacuum and in matter. Topics include solutions to Laplace's and Poisson's equations, multipole expansion of the electric potential, electric fields in matter, potential formulations of electrodynamics, electric and magnetic field boundary conditions, and electromagnetic waves. May be taught concurrently with PHY 553. Cannot receive credit for both PHY 553 and PHY 653.

PHY 658 Physics of Semiconductor Devices. 3(3-0), D. Prerequisite: PHY 352 and PHY 375 and PHY 391. Topics will be selected from: band structure and electron statistics in semiconductors, doping and carrier transport in homogeneous materials, p-n function and its characteristics under bias, bipolar devices, unipolar devices, MOSFETs, light-emitting diodes, semiconductor lasers, and integrated circuits. May be taught concurrently with PHY 558. Cannot receive credit for both PHY 558 and PHY 658.

PHY 675 Quantum Mechanics. 3(3-0), F. Prerequisite: PHY 375. A mathematical development of the principles of quantum mechanics and their application to selected systems. Topics include Schrodinger's equation, operators, Heisenberg uncertainty principle, angular momentum, and applications, including the hydrogen atom. May be taught concurrently with PHY 575. Cannot receive credit for both PHY 575 and PHY 675.

PHY 691 Applied Group Theory. 3(3-0), D. Prerequisite: PHY 333. Recommended Prerequisite: PHY 533 or PHY 633; and MTH 533 or MTH 633. Basic concepts of point groups as applied to molecular vibrations in relation to Raman and IR emission and absorption; continuous groups as applied to quantum mechanics. May be taught concurrently with PHY 590. Cannot receive credit for both PHY 590 and PHY 691.

PHY 701 Workshop on Topical Issues in Science Education. 1-3, D. Prerequisite: permission. Workshop to upgrade understanding of selected topics in science, and improve elementary, middle school and/or secondary science teaching. Each workshop will include performance and analysis of appropriate investigations to enhance understanding of the selected topics. Number of class hours determined by semester hours of credit. Variable content course. May be repeated to a maximum of 6 hours provided the topics are different.

PHY 785 Physics Laboratory for Teachers. 3(1-4), D. Prerequisite: permission. Performance and analysis of secondary laboratory experiments in physics.

PHY 790 Seminar in Physics. 2(2-0), D. Prerequisite: permission. Extensive paper on agreed topic in physics or astronomy to be read before staff seminars. May be repeated to a total of 4 hours.

PHY 799 Research in Natural and Applied Sciences. 1-6, D. Prerequisite: permission of department head. Supervised research in the natural and applied sciences. May be repeated, but no more than 12 hours may be counted toward the masters degree. Credit may not be applied toward the Master of Science degree in Materials Science.

MATERIALS SCIENCE COURSES

MAT 609 Special Topics in Materials Science. 1-3, D. Prerequisite: permission of instructor. Variable content course. Topics to be chosen from current areas of interest in Materials Science. May be repeated to a total of 6 hours with a different topic. May be taught concurrently with MAT 509. Cannot receive credit for both MAT 509 and MAT 609.

MAT 640 Thermodynamics of Materials. 3(3-0), F. Prerequisite: PHY 343 or CHM 506 or CHM 606. Review of classical thermodynamics, equilibrium in thermodynamic systems, the statistical interpretation of entropy, unary and multi-component systems, thermodynamics of phase diagrams and phase equilibrium. May be taught concurrently with MAT 540. Cannot receive credit for both MAT 540 and MAT 640.

MAT 651 Introduction to Materials Science. 3(3-0), F. Prerequisite: PHY 375 or CHM 507 or CHM 607. Investigation of the relationships that exist between the structure, properties, processing and performance of materials. Different types of materials will be studied with a special emphasis on polymers and semiconductors. Structure-property correlations, including electronic, thermal, and mechanical properties, will be presented for these materials. May be taught concurrently with MAT 550. Cannot receive credit for both MAT 550 and MAT 651.

MAT 681 Structure of Solids. 3(3-0), F. Prerequisite: PHY 375 or CHM 507 or CHM 607. Review of quantum mechanics, followed by an in-depth study of crystal structures, energy band structures in solids, lattice dynamics, and a survey of the physical properties of solids. May be taught concurrently with MAT 580. Cannot receive credit for both MAT 580 and MAT 681.

MAT 720 Advanced Quantum Mechanics. 3(3-0), S. Prerequisite: PHY 575 or PHY 675. Advanced topics in quantum mechanics including variational methods, approximation techniques, time-independent and time-dependent perturbation theory, second quantization, and the interactions of light with matter.

MAT 750 Experimental Design. 3(1-4), F. Laboratory techniques necessary for the development of instrumentation. Topics will include elementary computer interfacing, prototype design, mechanical and electronic construction, and reliability testing. The student will develop, design and build a test instrument and study each of the above topics during this process.

MAT 758 Optoelectronic Materials. 3(3-0), S. Prerequisite: MAT 681. Course includes the study of advanced electronic properties of materials, lattice dynamics, and a survey of the optical-electronic interactions in materials.

MAT 760 Experiments in Physical Characterization. 3(1-4), S. Prerequisite: MAT 651 and MAT 681. Laboratory techniques in electronic, optical, and thermal characterization of materials. Students will become familiar with equipment and procedures used in research and commercial laboratories.

MAT 770 Vapor Synthesis of Materials. 3(1-4), S. Prerequisite: MAT 640 and MAT 651. Experimental techniques in the vapor deposition of thin film materials used in the electronics industry. Some modification of the resulting films including chemical doping and ion implantation will also be studied. Experimental methods including computer control and analysis will be studied.

MAT 780 Polymer Preparation and Characterization. 3(1-4), S. Prerequisite: MAT 651 and MAT 760. Preparation of polymers, including the techniques of condensation polymerization, free radical polymerization, and if time permits, plasma polymerization. Characterization experiments will be viscosity measurements, differential scanning calorimetry, and thermal gravimetric analysis. Film preparation including spin coating, aspiration, and doctor blade systems will also be investigated.

MAT 790 Statistical Applications in Materials Science. 3(3-0), S. Prerequisite: MAT 651. Selective topics in materials science important to the design, testing, fabrication, and manufacture of materials whose underlying theme is mathematical modeling based in statistical methods. The topics include mass transport in solids, atomic diffusion on surfaces, adsorption and desorption on surfaces, epitaxial growth, degradation of materials, queuing theory, and operations research.

MAT 798 Seminar in Materials Science. 1, S. Prerequisite: candidate for the MS degree in Materials Science. Selected topics in materials science of a theoretical, experimental, or applied nature with an emphasis on recent developments and their impact. May be repeated for a maximum of 4 hours.

MAT 799 Research in Materials Science. 1-6, D. Prerequisite: permission. Supervised research in areas of materials science. May be repeated, but no more than 12 hours may be counted toward the M.S. degree.