COLLEGE OF NATURAL AND APPLIED SCIENCES

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Interdisciplinary Programs

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

Master of Science, Administrative Studies: Environmental Management Option

Department of Agriculture

W. Anson Elliott, Department Head
Dennis Schmitt, Graduate Director

Master of Science, Plant Science
Master of Science in Education, Secondary Education

Department of Biology

S. Alicia Mathis, Department Head
Thomas E. Tomasi, Graduate Director

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

Department of Chemistry

Paul M. Toom, Acting Department Head
Mark Richter, Graduate Director

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

Department of Computer Science

Lloyd A. Smith, Department Head

Department of Fashion and Interior Design

Michele M. Granger, 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 Education, Secondary Education
Graduate Certificate: Geospatial Information Science (offered jointly with the University of Missouri – Rolla)

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 505 (PHY) Intellectual Foundations of Science and Technology. 3(3-0) S. Prerequisite: 70 hours including 8 hours of natural science. A 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.

SCI 580 Topics in Science Education. 1-4 D. Prerequisite: Senior level or graduate standing or permission of instructor. A variable content course to provide the offering of selected topics of interest to science teachers in the elementary, middle school, secondary or college classroom. May be repeated up to 6 hours when the topic varies. No more than 6 hours may be counted toward a degree.

SCI 680 Advanced Topics in Science Education. 1-4 D. Prerequisite: Graduate standing, completed 12 hours of graduate coursework or permission of instructor. A variable content course for the offering of selected topics of interest to science teachers in the elementary, middle school, secondary or college classroom. May be repeated up to 6 hours when the topic varies. No more than 6 hours may be counted toward a 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)

Dennis Schmitt, Program Director
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DennisSchmitt@missouristate.edu

PROGRAM DESCRIPTION

The Master of Natural and Applied Science 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 600 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 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** – see item 2 under Admission Requirements for regular MNAS degree.

DEPARTMENT OF AGRICULTURE

W. Anson Elliott, Department Head

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Agriculture@missouristate.edu

GRADUATE FACULTY

Professor: W. Anson Elliott, Ben D. Fuqua, Lyndon N. Irwin, Martin L. Kaps, Laszlo G. Kovacs, Thomas L. Perkins, Michael P. Roling, Dennis L. Schmitt, Pamela Trewatha

Associate Professor: Clydette Alsup, James B. Hutter, Wenping Qiu, Arbindra P. Rimal, Gary W. Webb, Karl L. Wilker

Assistant Professor: Elizabeth L. Walker , Weston Walker

Emeritus Professor: Harry R. James, J.N. Smith, Charles E. Stufflebeam, Howard G. Townsend, Jr

MASTER OF SCIENCE, PLANT SCIENCE

Dennis Schmitt, 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.

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 544) and biometry (BIO 550) or applied statistics (MTH 545) 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 600 through 699 inclusive.
4. **Colloquium.** Two hours of credit must be earned in FRS 600, 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 listed under "Graduate College: Interdisciplinary Programs".

AGRICULTURE REQUIREMENTS

AGR 618 Topics in Agricultural Education	3 hrs
Additional course work in Agriculture	12 hrs
	TOTAL 15 hrs

AGRICULTURE COURSES

AGR 690 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 697 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 698 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 699 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 maximum of 6 hours will be applied toward a master's degree.

AGRICULTURAL BUSINESS COURSES

AGB 514 International Agricultural Trade. 3(2-2) S. 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.
AGB 524 (424) Agricultural Prices. 3(2-2) F, S. Prerequisite: AGB 334. Factors influencing the level and movement of agricultural commodity prices and prices of agricultural inputs.
AGB 584 (484) Farm Business Management. 3(2-2) F, S. Prerequisite: AGB 144. Economic principles applied to the organization and operation of agricultural units; tools of decision making; and factor allocation.

AGRICULTURAL EDUCATION COURSES

AGE 508 Teaching Adults in Vocational Education.
3(3-0), D. (Identical with SEC 527, and TEC 527) 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.
AGE 518 Agriculture Education: Special Topics. 1-3 D. Prerequisite: permission of instructor. Special study of agricultural education topics not covered in other courses. Courses may be repeated to 5 hours if topic varies.

AGE 548 Agriculture in the Classroom. 1(1-0) SU. Course is designed to help elementary teachers better appreciate the importance of agriculture in their students' lives and to better understand Missouri agriculture. Course stresses integration of resources available from the agricultural industry across the curriculum.
AGE 558 (SEC) Teaching of Agriculture. 3(3-0) S. Prerequisite: SEC 302 and EDC 350 and 20 hours in agriculture and admission 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. This course may not be taken pass/not pass.
AGE 568 (468) Course and Program Building in Agricultural Education. 3(3-0) S. Prerequisite: AGE 318. Organization and analysis of agricultural instruction courses and programs including the adoption of resource materials to meet individual student needs.
AGE 578 (478) Methods of Teaching Agricultural Management. 2(2-0) S. Prerequisite: SEC 404, junior standing, and permission. Identification, development, and utilization of supervised agriculture experience programs in Agricultural Education that includes methods of teaching program management, record keeping, and appropriate methodologies.
AGE 588 (488) Methods of Teaching Agricultural Laboratory Management. 2(1-2) S. Prerequisite: SEC 404, junior standing, and permission. 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.
AGE 618 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. Students may repeat course; however, only 9 hours will count towards the student's graduate program of study.
AGE 628 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 638 Induction Year Teaching II. 2(2-0) F, S. Prerequisite: AGE 628. Course for the professional development of second-year teachers of agriculture. The course is a continuation of AGE 628 Induction Year Teaching I and focuses on the pedagogical knowledge, skills, and attitudes and managerial skills needed by beginning teachers of agriculture.

AGRICULTURAL TECHNOLOGY COURSES

AGT 521 Selection and Organization of Industrial Education. (Identical with AGV 521). 3(3-0) D. Prerequisite: AGT 416 or concurrent enrollment, AGT 420 or concurrent enrollment, or permission. 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.

AGRICULTURAL VOCATIONAL COURSES

AGV 520 Occupational Analysis. (Identical with BSE 520). 1-2 D. Analysis and breakdown of broad occupations or specific jobs into basic elements for instructional purposes. May be repeated to a total of 2 hours when topic varies.
AGV 521 Selection and Organization of Industrial Education. (Identical with AGT 521). 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.
AGV 522 Philosophy of Vocational Education. (Identical with SEC 522, BSE 522). 1-3 D. Philosophical foundations of vocational education; philosophies of vocational education in the contemporary school. Meets Missouri Vocational Education certification requirements. May be repeated to a maximum of 3 credit hours when topic varies.
AGV 523 Guidance for Vocational Development. (Identical with BSE 523, GAC 523). 1-3 D. Materials, procedures, and problems involved in the guidance of individuals in the selection of, preparation for, and advancement in a vocation. May be repeated to a total of 3 hours when topic varies.
AGV 525 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.
AGV 526 Coordination of Cooperative Education. (Identical with BSE 526 and SEC 526). 1-2 D. Problems and procedures in organizing and operating part time cooperative and evening occupation programs. May be repeated to a total of 2 hours when topic varies.
AGV 527 Teaching Adults in Vocational Education. (Identical with AGE 508 and SEC 527). 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.
AGV 528 Measurement and Evaluation of Vocational Education Programs. (Identical with BSE 528 and SEC 528) 103 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. May be repeated to a total of 3 hours with departmental approval when topic varies.
AGV 576 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.
AGV 624 Organization and Administration of Vocational Education. (Identical with SFR 624). 1-3 D. Problems, procedures and local, state and federal relationships in the organization and administration of vocational education in the contemporary school. May be repeated to a total of 3 hours when topic varies.
AGV 626 Seminar in Industrial Education. 3(3-0) D. Presentation and discussion of professional or technical problems in the organization and management of programs and facilities in industrial education.
AGV 660 Special Investigations. 1-5 D. 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 joint investigations.

AGRONOMY COURSES

AGA 505 Advanced Soil Fertility. 3(2-2), D. Recommended: AGA 405. Theoretical and applied aspects of soil fertility emphasizing ion transport, nutrient availability and root absorption in soils-plant environments.
AGA 545 (445) Soil Survey and Land Appraisal. 3(2-2) D. Recommended: 6 credit 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.
AGA 555 Soil Genesis, Morphology and Classification II. 3(2-2) D. Recommended: AGA 345 and AGA 455. Pedogenetic processes, macro-morphology, micromorphology, redoximorphic features, and classification as related to soil taxonomy.
AGA 575 (475) Plant Improvement. 2(2-0) S. Recommended: AGA 105. Application of genetic principles to the improvement of crop plants. Includes self-pollinated, cross-pollinated, and asexually-propagated crops.
AGA 625 Advanced Soils Interpretation. 3(2-3) D. Recommended: AGA 345 and AGA 455. Field interpretation of physical and chemical properties, water relationships, and soil landscape relationships.

COLLEGE OF NATURAL AND APPLIED SCIENCES

ANIMAL SCIENCE COURSES

AGS 511 Animal Nutrition and Metabolism. 3(3-0), F. Recommended: CHM 200 or CHM 310. Utilization and metabolism of nutrients by domestic animals; role of vitamins and minerals.
AGS 612 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 616 Mammalian Reproductive Physiology. 3(3-0) S. Recommended: 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 513 (413) 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.

FRUIT SCIENCE COURSES

FRS 600 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 degree.
FRS 601 Advanced Pomology. 3(3-0) S. Prerequisite: BIO 544 or 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.
FRS 611 Viticulture. 3(3-0) S. Prerequisite: BIO 544 or permission of instructor. 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.
FRS 621 Enology. 3(3-0) S. Prerequisite: BIO 310 or permission of instructor. The course will study the chemistry, microbiology, and technology of modern wine production.
FRS 622 Enology Lab. 2(0-4) F. Prerequisite: FRS 621. Laboratory techniques in assessing wine production methods and quality.
FRS 630 Advanced Topics in Plant Science. 3(3-0) F. (Identical to AGR 630). 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 Grapes, Application of Field Collected Data to Computer Analysis. May be repeated to a total of 6 hours with differing topics. Variable Content Course.
FRS 631 Plant Genetic Engineering. 3(3-0) S. Prerequisite: BIO 235 or CHM 200 or CHM 310. Principles, methodology, and commercial applications of plant biotechnology. Includes brief introduction to nucleic acid structure, gene regulation, and genome organization in enkaryotic and prokaryotic organisms.
FRS 698 Research. 1-6 F, S, Su. Prerequisite: permission of instructor. Supervised research in areas of emphasis within the disciplines of plant science. May be repeated, but not more than 6 hours of FRS 698 may be counted toward the 32 hour requirement for the degree.
FRS 699 Thesis. 1-6 F, S, Su. Prerequisite: permission of instructor. Demonstration of capacity for research and independent thought culminating in a thesis. May be repeated. A maximum of 6 hours will be applied to the degree.

HORTICULTURE/PLANT SCIENCE COURSES

AGH 573 (473) Plant Propagation. 3(2-2) F. Recommended: Either AGE 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, graftings and micropropagations.
AGH 630 Advanced Topics in Plant Science. 3(3-0) F. (Identical to FRS 630) 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 Resistance in Viticulture, and Application of Field Collected Data to Computer Analysis. May be repeated to a total of 6 hours with differing topics. Variable Content Course.
AGH 653 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 673 Plant Growth-Regulation. 3(3-0) D. Prerequisite: permission of instructor. The role of natural and synthetic plant hormones and related components in the growth, reproduction and cultivation of plants.

DEPARTMENT OF BIOLOGY

S. Alicia Mathis, Department Head
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GRADUATE FACULTY

Professor: M. Christopher Barnhart, Daniel W. Beckman, Frank A. Einhellig, Janice S. Greene, John E. Havel, John S. Heywood, S. Alicia Mathis, Don L. Moll, Lynn W. Robbins, John G. Steiert, Thomas E. Tomasi
Associate Professor: Paul L. Durham, Brian D. Greene, Georgianna Saunders, D. Alexander Wait
Assistant Professor: L. Michelle Bowe, Kyoungtae Kim, Mark McKnight
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

Thomas E. Tomasi, 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 health-related fields. Some students completing the program have continued their education in doctoral programs, while others have accepted positions as ecologists, conservationists, 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 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 500 or 600-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/Sept 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 600-699 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 698 and 6 hours of BIO 699).
   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 690 and four hours of BIO 698 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. (See program requirements for the M.S.Ed., Secondary Education under "Graduate College: Interdisciplinary Programs".)

BIOLOGY REQUIREMENTS

Biology courses that includes a minimum of
3 hrs in courses numbered 600 or above **Total 15 hrs**

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

Contact Dr. Tamera Jahnke (See program requirements for the M.S.Ed., Secondary Education)

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 600 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 508 Environmental Microbiology. 3(2-2) F. Prerequisite: BIO 210 or BIO 310. The study of 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.
BIO 509 Stream Ecology. 4(2-4) S. Prerequisite: BIO 369; CHM 105 or CHM 170 plus CHM 175. 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 streams. Lectures, group discussion of reading, and laboratory and field exercise. One all-day Saturday field trip required.
BIO 511 Immunology. 3(2-2) F, S. Prerequisite: BIO 210 or BIO 310. Fundamental principles of immunology. Lecture emphasis on the structure and functions of antigens, antibodies, surface receptors, antigen-antibody interactions, immuno-globulin 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.
BIO 512 Industrial Microbiology. 3(2-2) D. Prerequisite: BIO 210 or BIO 310. 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.
BIO 515 Evolution. 3(3-0) F, S. Prerequisite: BIO 235 and either MTH 135 or MTH 138. 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.
BIO 517 Microbial Physiology and Metabolism. 4(2-4) F. Prerequisites: BIO 210 or BIO and either CHM 200 or CHM 310. 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 and responses by microorganisms to environmental changes.
BIO 520 Pathogenic Microbiology. 3(3-0) S. Prerequisite: BIO 210 or BIO 310. Fundamental principles of pathogenic microbiology; transmission, infection and control of the pathogen.
BIO 527 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 the area. Course is scheduled irregularly during academic breaks and may be preceded by several lectures in preparation for the trip. An incidental fee may be charged; cost will vary. May be repeated to a total of 6 credits with a maximum of 3 credits to be applied to the major in biology.
BIO 530 Phycology. 3(2-2) S. Prerequisite: BIO 369. The structure, function, ecological significance, and diversity of algae. Emphasis will be placed on field studies, isolation and growth, and physiological characteristics.
BIO 531 Economic Botany. 2(2-0) F-even. Prerequisite: BIO 102 or BIO 121. Distribution and origin of plants which yield food, poison, drugs, spices, fibers, oils, and other products generally used by man. Methods of preparations and analyses of products and ingredients.
BIO 532 Principles of Fisheries Management. 3(2-2) S. Prerequisite: BIO 369 or BIO 373. 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.
BIO 533 Wetlands Ecology. 3(2-2) F. Prerequisite: BIO 369 and either CHM 105 or CHM 160. The composition, structure, function and importance of wetlands ecosystems. Comparisons of different wetland types, hydrology, nutrient cycles, plants and animals and their adaptations, and conservation strategies.
BIO 539 Biogeography. 2(2-0) F. Prerequisites: BIO 121 and BIO 122. Study of patterns of distribution of organisms in space and in time.
BIO 540 Applications of Molecular Markers. 4(2-4) D. Prerequisite: BIO 235 and permission. Introduction to the use of molecular markers in biological research. Topics covered include methods for identifying genetic variation t 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.
BIO 544 (344) Plant Physiology. 4(3-2) D. Recommended: CHM 200 or CHM 310. Basic chemical and physical principles of plant function considering water relationships, nutrient transport, mineral nutrition, photosynthesis, respiration, and phytohormones.
BIO 545 Agrostology. 2(1-2) FO. Prerequisite: BIO 334. Identification of local, native, and economically important grasses.
BIO 546 Plant Morphology. 4(2-4) D. Prerequisites: BIO 121 and BIO 122. A study of the form, structure, and evolution of plants.
BIO 550 Statistical Methods for Biologists. 3(3-0) F, S. Prerequisite: BIO 235 and eligibility for MTH 261. Scientific methodology, experimental design, statistical analysis, and data interpretation applied to biological questions.
BIO 551 Advanced Statistical Methods for Biologists. 2(1-2) D. Prerequisites: BIO 550. 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.

BIO 560 Population Genetics and Evolutionary Mechanisms. 3(3-0) D. Prerequisites: BIO 515 and a course in statistics, or permission. The theory of genetic variation in populations, with emphasis on quantitative description of the mechanisms of biological evolution.
BIO 562 Limnology. 4(2-4) S. Prerequisites: BIO 369; CHM 105 or CHM 170 plus CHM 175. Physical, chemical, and biological functions of freshwater ecosystems. Laboratory includes mapping, lake models, water chemistry, and surveys of taxonomic diversity. Two all-day Saturday labs plus one weekend field trip required.
BIO 563 Population Ecology. 3(2-2) S. Prerequisites: BIO 369 and MTH 135 or 138. Discussion of factors controlling the distribution and abundance of populations. Quantitative descriptions of population dynamics is emphasized.
BIO 567 Physiological Ecology. 4(4-0), S-even. Prerequisites: BIO 361, BMS 308, or BIO 544; BIO 369. Physiological adaptations of plants and animals to environmentally stressful conditions and to ecological/evolutionary pressures.
BIO 571 Comparative Animal Physiology. 4(3-3) S-odd. Prerequisites: BIO 361, BMS 308 or BMS 566, 5 hours organic chemistry. Organ/system function in a wide range of invertebrate and vertebrate animals.
BIO 573 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.
BIO 574 Aquatic Entomology. 2(1-3) D. Prerequisites: BIO 167 and 371 or permission. Aquatic insects, ecology, and taxonomy with emphasis on field applications.
BIO 575 Ichthyology. 3(2-2) F. Prerequisites: 12 hours in biology. Taxonomy, distribution, life histories, and ecology of fish with emphasis on Missouri forms.
BIO 576 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.
BIO 577 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.
BIO 578 Behavioral Ecology. 4 (3-2) S. Prerequisites: BIO 369 and MTH 340 or BIO 550, or permission. Fundamental principles of animal behavior with an emphasis on the study of the ecological and evolutionary processes that influence behavior.
BIO 579 Conservation Biology. 4 (3-2) D. Prerequisites: BIO 235 and BIO 369 or permission of instructor. An in-depth examination of the science of conservation from a biological perspective, with an examination of ethical and legal aspects of conservation.
BIO 584 Fish Ecology. 3(3-0) D. Prerequisite: BIO 369 and BIO 575. The biology of fishes in relation to environmental conditions at the individual, population, and community levels.
BIO 589 Game Management. 3(3-0) D. Prerequisite: BIO 373 and BIO 577. Management of game birds and mammals for recreational utilization.
BIO 590 Women in Science and Mathematics. 2(2-0) S. Prerequisite: completion of natural science and mathematics general education requirement. Discussion of female scientists and mathematicians, their personal lives, scientific discoveries, and related topics such as mentoring and career goals. (Does not count toward a major or minor in Biology). Students may not receive credit for both BIO 590 and CHM 590.
BIO 597 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.
BIO 610 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 synthesis, regulation of gene expression, and dynamics of cell growth. Lectures will supplement discussion sessions.
BIO 612 Advanced Immunology. 2(2-0) S. Prerequisite: BIO 511. Cellular aspects of the immune system.
BIO 622 Regulatory Mechanisms in Microorganisms. 2(2-0) S. Regulation of macromolecular synthesis and enzyme activity in bacteria and viruses.
BIO 625 Advanced Limnology. 2(2-0) D. Prerequisites: BIO 562. Advanced concepts of biological, chemical and physical limnology. Recent symposia, reviews, and primary literature are discussed.
BIO 626 Advanced Limnology Methods. 2(0-4) D. Prerequisites: BIO 562. Research and practical application of modern limnological methods.
BIO 628 Recent Advances in Biology. 1(0-2) F, S. Prerequisite: permission of the instructor. Selected topics in biology to be discussed using original literature as the focal point. Variable content. May be repeated when topic varies.
BIO 630 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 634 Advanced Plant Taxonomy. 4(2-4) D. Prerequisites: permission of instructor. Philosophy and principles of modern taxonomic procedures.
BIO 636 (536) Plant Ecology. 4(2-4) F. Prerequisites: BIO 369 or permission of instructor. 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. Students cannot receive credit for both BIO 436 and BIO 636.
BIO 655 Advanced Developmental Biology. 4 (3-2) S. Prerequisite: BIO 320 or permission. 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. Students cannot receive credit for taking both BIO 355 and 655.
BIO 660 Topics in the Teaching of Biology. 1-3 D. Prerequisite: permission of instructor. Biological concepts, information, practical experiences, and use of resource materials in the elementary, middle school and secondary classroom. Variable content course. May be repeated when topic varies.
BIO 661 Environmental Science for Educators. 2(1-2) F. Prerequisite: permission of instructor. Discussion of environ-mental issues, practical experiences in teaching environmental concepts, and awareness of environmental resource materials for the formal and non-formal classroom setting.
BIO 667 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 680 Vertebrate Anatomy and Evolution. 2(2-0), F, S. Vertebrate gross anatomy. Phylogeny and present status of organ systems in vertebrates.
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. Students cannot receive credit for both BIO 485 and 685.
BIO 690 Degree Paper in Biology. 2(2-0). Prerequisite: permission of advisor. Extensive paper on selected topics. May be repeated to total 4 hours. Exclusively satisfies requirements for non-thesis option, which also requires one BIO 690 paper to be presented orally to the department. Pass/not pass only.
BIO 694 Scientific Writing. 2(2-0) F. Organization and methods in scientific writing. Included are discussions 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 698 Research. 1-6. Prerequisite: permission of advisor. Supervised research in special biology areas. May be repeated, but no more than 6 hours may be counted as credit toward the degree. Pass/not pass only.
BIO 699 Thesis. 1-6. 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 toward the degree. Pass/not pass only.

MARINE BIOLOGY COURSES

(All of the following classes are offered only in the summer, and are taught only at the Gulf Coast Research Laboratory, Ocean Springs, Mississippi. See the Department Head or your advisor for more details.)

BIO 523 Marine Science for Teachers I. 2(2-0) Su. Prerequisites: 12 hours in biology. A course designed to introduce students, particularly in-service teachers, to the study of marine science and to promote the teaching of marine biology at all grade levels. Concurrent enrollment in BIO 524 is required. (Must be taken at Gulf Coast Research Lab, Ocean Springs, MS).

BIO 524 Marine Science for Teachers I Lab. 1(0-2) Su. Prerequisite: concurrent enrollment in BIO 523. (Must be taken at Gulf Coast Research Lab, Ocean Springs, MS).

BIO 534 Coastal Vegetation. 2(2-0) Su. Prerequisites: 10 hours of biology including BIO 121 and BIO 122. 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. Concurrent enrollment in BIO 535 required (Must be taken at Gulf Coast Research Lab, Ocean Springs, MS).

BIO 535 Coastal Vegetation Lab. 1(0-2) Su. Prerequisite: concurrent enrollment in BIO 534. Laboratory portion of BIO 534. Concurrent enrollment in BIO 534 required. (Must be taken at Gulf Coast Research Lab, Ocean Springs, MS).

BIO 537 (564) Salt Marsh Plant Ecology. 2(2-0) Su. Prerequisites: BIO 122 or BIO 134; and BIO 334; and BIO 544; and BIO 369. 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 inter-relationships. Primary productivity and relation of marshes to estuaries and associated fauna. Concurrent enrollment in BIO 536 required. (Must be taken at Gulf Coast Research Lab, Ocean Springs, MS).

BIO 538 Salt Marsh Plant Ecology Lab. 2(0-4) Su. Prerequisite: concurrent enrollment in BIO 537 required. Laboratory portion of BIO 537. (Must be taken at Gulf Coast Research Lab, Ocean Springs, MS).

BIO 551 Biometry Laboratory. 2(1-2) F, S. Prerequisite: BIO 550 or permission. The statistical analysis of biological data using computer software.

BIO 555 (578) Marine Ichthyology. 3(3-0) Su. Prerequisites: junior standing; 16 hours of biology including BIO 121, BIO 122, BIO 235, and BIO 380. This course provides the student with a strong general background in the biology of marine fishes. Emphasis is placed on the principles involved in the classification and taxonomy of marine and estuarine fishes. Concurrent enrollment in BIO 556 required. (Must be taken at Gulf Coast Research Lab, Ocean Springs, MS).

BIO 556 Marine Ichthyology Lab. 3(0-6) Su. Laboratory concurrent enrollment in BIO 555. Concurrent enrollment in BIO 555 required. (Must be taken at Gulf Coast Research Lab, Ocean Springs, MS).

BIO 557 (579) Marine Fisheries Management. 2(2-0) Su. Prerequisite: permission of instructor. 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. Concurrent enrollment in BIO 558 required. (Must be taken at Gulf Coast Research Lab, Ocean Springs, MS).

BIO 558 Marine Fisheries Management Lab. 2(0-4) Su. Prerequisite: concurrent enrollment in BIO 557. Laboratory portion of BIO 557. (Must be taken at Gulf Coast Research Lab, Ocean Springs, MS).

BIO 565 Marine Ecology. 3(3-0) Su. Prerequisites: 16 hours of biology, including general botany and invertebrate zoology. 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. (Must be taken at Gulf Coast Research Lab, Ocean Springs, MS).

BIO 566 Marine Ecology Lab. 2(0-4) Su. Laboratory portion of BIO 565. Concurrent enrollment in BIO 565 required. (Must be taken at Gulf Coast Research Lab, Ocean Springs, MS).

BIO 587 (582) Marine Invertebrate Zoology. 3(3-0) Su. Prerequisites: 16 hours of zoology. A concentrated study of the free-living marine and estuarine invertebrates of MS 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. Concurrent enrollment in BIO 588 required. (Must be taken at Gulf Coast Research Lab, Ocean Springs, MS).

BIO 588 Marine Invertebrate Zoology Lab. 3(0-6) Su. Prerequisite: concurrent enrollment in BIO 587 required. Laboratory portion of BIO 587. (Must be taken at Gulf Coast Research Lab, Ocean Springs, MS).

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, Paul M. Toom, Anthony P. Toste
Associate Professor: Bryan Breyfogle, Dean A. Cuebas, Nikolay Gerasimchuk
Assistant Professor: Gary A.J. Meints, Chad J. Stearman, Erich Steinle
Emeritus Professor: Robert L. Ernst, Wyman K. Grindstaff, Franklin R. Hoggard, James F. O'Brien, Ralph W. Sheets, Vernon J. Thielmann, Clifton C. Thompson, James M. Wilbur, Jr.

MASTER OF SCIENCE, CHEMISTRY

Mark Richter, Graduate Director
Temple Hall, Room 477, Phone (417) 836-5508
MarkRichter@missouristate.edu

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 531, CHM 545, CHM 525, and CHM 507, 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 600 or above with at least 6 hours of 600-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 545, CHM 531, CHM 525, CHM 506 and CHM 507*. 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 507.

4. **Colloquium**. 2 hours of credit must be earned in CHM 600, 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 698 and 6 hours of CHM 699. 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. (See program requirements for the M.S.Ed., Secondary Education under Graduate College Interdisciplinary Programs)

CHEMISTRY REQUIREMENTS

Chemistry course work including a minimum of 3 hours in courses numbered 600 or above. **Total 15 hrs**

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

Contact Dr. Tamera Jahnke. (See program requirements for the M.S.Ed., Secondary Education)

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 600 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 502 Techniques of Instrumental Analysis. 4(3-3) F. Prerequisite: C or better in either CHM 200 or CHM 310; and C or better in CHM 330. Recommended: 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 or minor if the student passes CHM 531.

CHM 505 Fundamentals of Physical Chemistry. 4(3-3) S. Prerequisite: 20 hours of chemistry course work 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 or minor if the students passes CHM 506.

CHM 506 Physical Chemistry I. 3(3-0) F. Prerequisite: C or better in either CHM 170; MTH 280 or MTH 288 (or concurrent enrollment in MTH 280 or MTH 288). Recommended: 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 507. This course may not be taken pass/not pass.

CHM 507 Physical Chemistry II. 3(3-0) S. Prerequisite: "C" grade or better in CHM 506. Recommended: CHM 375. Continuation of CHM 506. Kinetics, quantum theory, and spectroscopy.

CHM 508 Beginning Physical Chemistry Laboratory. 2(0-4) F. Prerequisites: C or better in either CHM 330; C or better in CHM 506 (or concurrent enrollment in CHM 506. Experiments in physical chemistry employing basic principles and experimental techniques.

CHM 509 Intermediate Physical Chemistry Laboratory. 2(0-4) S. Prerequisite: CHM 507 or concurrent registration. Intermediate experiments in physical chemistry combining basic principles.

CHM 514 Polymer Chemistry. 3(3-0) SE. Prerequisite: C or better in CHM 311 or CHM 312; and either CHM 480 or CHM 506; or permission from department head. 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.

CHM 515 Intermediate Inorganic Chemistry. 3(3-0) F. Prerequisite: admission to a graduate program. 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 525. CHM 375 may be taught concurrently with CHM 515. Students cannot receive credit for both CHM 375 and CHM 515.

CHM 525 Advanced Inorganic Chemistry. 3(3-0) S. Prerequisite: C or better in CHM 375; CHM 507 (or concurrent enrollment in CHM 507). Theories and techniques of modern inorganic chemistry; correlation of theories with inorganic compounds.

CHM 531 Advanced Analytical Methods. 4(3-3) F. Prerequisites: C or better in CHM 330 and CHM 507. 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.

CHM 545 Advanced Organic Chemistry. 3(3-0) F. Prerequisites: "C" grade or higher in CHM 311 or CHM 312 and either CHM 505 or CHM 506 or permission. Structure, reaction mechanisms, stereochemistry and other topics of theoretical nature in organic and polymer chemistry.

CHM 550 Biochemistry II. 3(3-0) S. Prerequisite: C or better in CHM 450; and either CHM 505 or CHM 506; or permission from department head. Bioenergetics-Metabolism of biomolecules including carbohydrates, lipids, amino acids and nucleotides. Photo-synthesis. Nitrogen metabolism. Mechanisms of hormone action.

CHM 551 Advanced Biochemistry Laboratory. 2(0-4) D. Prerequisite: CHM 550 (or concurrent enrollment in CHM 550). Emphasis on modern techniques in the biochemistry laboratory; enzymology; protein purification and analysis; protein structure determination; isoelectric focusing; HPLC; trace techniques.

CHM 570 Chemical Bonding. 3(3-0) FE. Prerequisite: CHM 507 or permission from department head. Quantum mechanics; atomic and molecular structure; computational procedures. Independent study project required.

CHM 597 (501) Special Topics in Chemistry. 1-3 D. Prerequisite: 18 hours of chemistry or instructor permission. Selected topics of a theoretical or applied nature. May be repeated up to a total of 6 hours with differing topics.

CHM 600 Chemistry Colloquium. 1(1-0) F, S. Prerequisite: admission to MS in Chemistry program or permission of department head. 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 of CHM 600 may be counted toward the 32 hour requirement for the M.S. degree.

CHM 601 Chemistry Seminar. 1(1-0) F, S. Prerequisite: permission of graduate coordinator. 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 600 must be enrolled in CHM 601. This course will be taken on a pass/not pass basis only. Hours earned will not count toward the 32 required for the M.S. in Chemistry degree.

CHM 610 Special Topics in Chemical Education. 1-3 D. Prerequisite: college work 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 615 Chemistry of Environmental Systems I. 3(3-0) F. Prerequisite: permission of instructor or department head. Chemistry of pollution. Sources, effects, detection and abatement of pollutants in air, water and soil. CHM 425 may be taught concurrently with CHM 615. Students cannot receive credit for both CHM 425 and CHM 615.

CHM 616 Chemistry of Environmental Systems II. 3(3-0) S. Prerequisite: CHM 615 or permission of instructor or department head. Chemistry of pollution. Sources, effects, detection and abatement of pollutants in air, water and soil. CHM 426 may be taught concurrently with CHM 616. Students cannot receive credit for both CHM 426 and CHM 616.

CHM 617 Chemistry of Environmental Systems Laboratory. 2(0-4)S. Prerequisite: CHM 616. Techniques and procedures for environment monitoring to test natural samples. Applications and limitations of wet chemical and instrumental methods such as atomic absorption, gas chromatography, and absorption spectrophotometry. CHM 427 may be taught concurrently with CHM 617. Students cannot receive credit for both CHM 427 and CHM 617.

CHM 620 Topics in Theoretical Chemistry I. 3(3-0) D. Prerequisite: college work sufficient to meet Missouri certification standards in chemistry for secondary teaching or permission. Nature of matter including atomic structure, chemical bonding, and spectroscopy.

CHM 625 Organometallic Chemistry. 3(3-0) FE. Prerequisite: CHM 525. An in-depth examination of the structure, properties, and reactions of molecules containing one or more metal atoms bonded to organic fragments.

CHM 631 Advanced Techniques in Chemical Analysis. 3(3-0) SO. Prerequisite: CHM 531 or permission. Advanced topics in modern instrumental analysis, instrumentation, and methods, including data acquisition methods, data manipulation and analysis, and electronics.

CHM 635 Investigations in Chemistry for Teachers. 31(4) S. Prerequisite: college work sufficient to meet Missouri certification standards for secondary/middle school science teaching or permission. Techniques in performing science investigation with application to secondary and middle school science. CHM 435 may be taught concurrently with CHM 635. Students cannot receive credit for both CHM 435 and CHM 635.

CHM 640 Seminar. 2(2-0) D. Prerequisite: permission of department head. Extensive paper on selected topics to be read before staff seminars. May be repeated to total 4 hours. Satisfies requirements for Option II.

CHM 645 Physical Organic Chemistry. 3(3-0) D. Prerequisite: CHM 545. An in-depth study of the experimental techniques and physical principles used for the determination of organic reaction mechanisms.

CHM 650 Advanced Topics in Biochemistry. 3(3-0) SO. Prerequisite: CHM 550. 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. May be repeated to a total of 6 hours with differing topics. Variable content course.

CHM 670 Chemical Kinetics. 3(3-0) FO. Prerequisite: CHM 507. 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 690 Advanced Topics in Chemistry. 1-3 D. Prerequisite: recommendation of student's advisory committee. 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. May be repeated up to 6 hours with differing topics. Variable content course.

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 698 Research. 1-4, F, S. Prerequisite: admission of MS in Chemistry program or permission of department head. Supervised research in special chemistry areas. May be repeated, but not more than 6 hours of CHM 698 may be counted toward the 32-hour requirement for the degree.

CHM 699 Thesis. 1-6 D. Prerequisite: admission to MS in Chemistry program or permission of department head. Independent research and study connected with preparation of thesis. Not more than 6 hours of CHM 699 may be counted toward the 32-hour requirement for the degree.

DEPARTMENT OF COMPUTER SCIENCE

Lloyd A. Smith, Department Head

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http://www.cs.missouristate.edu

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 500 Hardware, Software and Troubleshooting Personal Computers. 3(2-2) D. An introduction to the installation, maintenance, troubleshooting, upgrading, simple repair, and management of personal computer found in educational settings. This course will provide numerous laboratory experiences providing hands-on experience with a goal of enabling students to support personal computer laboratories found in PK-12 schools. This course cannot be taken for credit toward a computer science major or minor.

CSC 505 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. This course cannot be taken for credit toward a computer science major or minor.

CSC 510 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. This course cannot be taken for credit on a computer science major or minor.

CSC 521 Compiler Construction. 4(3-2) D. Prerequisite: CSC 333. 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.

CSC 526 Methods of Optimization. 3(3-0) D. Prerequisites: CSC 421or MTH 421; and MTH 533. Convex sets, classical optimization of functions, constrained optimization, search techniques, linear and nonlinear optimization, applications to applied problems.

CSC 596 Special Readings. 1-3 F, S. Prerequisites: CSC 325 and permission of the department head. Periodic conferences with an advisor are required. May be repeated to a total of 6 hours.

CSC 625 Computer Graphics. 3(3-0) F. Prerequisite: CSC 232, and MTH 215 or MTH 315. An 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 will be stressed. May be taught concurrently with CSC 425; if so, students in CSC 625 will do additional work beyond that required for CSC 425. Students cannot receive credit for both CSC 425 and CSC 625.

CSC 635 Data Mining. 3(3-0) D. This course studies the emerging technology of data mining - the automated extraction of patterns and information from data. The focus will be on understanding the algorithms underlying date 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 435. Students cannot receive credit for both CSC 635 and CSC 435.

CSC 640 Artificial Intelligence. 3(3-0) S. Prerequisite: CSC 325 or permission. Techniques of artificial intelligence, including study of expert systems, natural language processing, search strategies, computer vision and robotics. May be taught concurrently with CSC 440; if so, students in CSC 640 will do additional work beyond that required for CSC 640. Students cannot receive credit for both CSC 440 and CSC 640.

CSC 645 Computer Speech, Music and Images. 3(3-0) D. This is an applied course focusing on the technical aspects of computer-based multi-media - - 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 multi-media data capture and representation, methods of data compression, multi-media information retrieval, and multi-media standards. May be taught concurrently with CSC 445. Students cannot receive credit for both CSC 645 and CSC 445.

CSC 665 Computer Networks. 3(3-0) F. Prerequisite: CSC 232. 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 465; if so, students in CSC 665 will do additional work beyond that required for CSC 465. Students cannot receive credit for both CSC 465 and CSC 665.

CSC 667 Wireless Networks. 3(3-0) S. Prerequisite: CSC 465 or CSC 665. An introduction to the fundamental theory, concepts and techniques of wireless communication, with wireless networks, 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 telecommunication network. Topics include wireless and ad hoc networks, enabling technologies, multiplexing, protocol design, network security, and quality of services. May be taught concurrently with CSC 467. Students cannot receive credit for both CSC 467 and CSC 667.

CSC 687 Computing for Bioinformatics. 3(3-0) D Prerequisite: Any one of CSC 121, CSC 125, CSC 131, CSC 232, BMS 231, BIO 235 or CHM 350. 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 487; if so, students in CSC 687 will do additional work beyond that required for CSC 487. Students cannot receive credit for both CSC 487 and CSC 687.

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 490. Students cannot receive credit for both CSC 490 and CSC 690.

CSC 698 Research in Computer Science. 1-4 F. S., Prerequisite: permission of department head. Supervised research in computer science. May be repeated, but not more than 6 hours may count toward the MNAS degree.

CSC 699 Thesis. 1-6, D. Prerequisite: permission of instructor. Independent research and study connected with preparation of thesis. Not more than 6 hours may be counted toward the MNAS degree.

DEPARTMENT OF FASHION AND INTERIOR DESIGN

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GRADUATE FACULTY

Professor: Michele M. Granger, Carrie J. Ireland
Assistant Professor: Damayanthie Eluwawalage
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 Dr. Michele Granger and see program requirements for the M.S.Ed., Secondary Education.

FAMILY AND CONSUMER SCIENCES REQUIREMENTS

A minimum of 3 hours of course work must be in Consumer and Family Studies courses numbered 600 or above.
Consumer and Family Studies courses **15 hrs**

CLOTHING AND TEXTILE COURSES

CTM 580 Senior Collection: Line Development. 3(1-4) S. Prerequisite: "C" grade or better in CTM 387 and CTM 427. Production of an apparel line from the conceptualization to the construction of sample garments. Three to five garments required in the student's designer's line. Students must get a grade of C or better to graduate.
CTM 583 Product Performance Evaluation. 3(2-2) S. Pre-requisite: CHM 105 or CHM 107 or CHM 160; and a "C" grade or better in CTM 283. Testing and analysis of textile products to determine quality, performance, use, and serviceability.
CTM 585 Establishing a Fashion Business. 3(3-0) S. Prerequisite: "C" grade or better in CTM 485. Entrepreneurial concepts of opening a business through the development of a business plan. Student must get a grade of C or better to graduate.
CTM 682 Graduate Seminar in Clothing and Textiles. 2(2-0) S. Prerequisite: 12 hours of graduate credit or permission. Selected topics in clothing and textiles that involve 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 500 Issues in Consumer and Family Studies. 1-3 D. Prerequisite: Senior or graduate standing, or permission. Advanced inquiry into specialized areas of study in home economics 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.
CFS 502 (402) Study Tour. 1-3 D. Prerequisite: junior or senior classification or permission. Study of, and/or visits to, mills, factories, stores, museums, hospitals, laboratories, design studios and/or trade markets.
CFS 507 Student Organizations in Vocational Family and Consumer Sciences. 1(1-0) F. Prerequisite: CFS 335 and concurrent enrollment in CFS 512 or permission of instructor. Methods of organizing student groups in Family and Consumer Sciences and occupational Family and Consumer Sciences programs; techniques of working with students in individual and group projects; leadership training.
CFS 512 Teaching Family and Consumer Sciences. 3(2-2) F. Prerequisite: CFS 335 and concurrent enrollment in CFS 507 or permission of instructor. 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 the checkpoint II for the Professional Portfolio is a component of this course. Credited only on B.S. in Education (Vocational Family and Consumer Studies). A grade of "C" or better is required in this course. This course may not be taken pass/not pass.
CFS 515 Organization of Occupational/Vocational Programs. 3(2-2) S. Prerequisite: CFS 507 and CFS 512 or permission of instructor. Investigation of the organization and administration of occupational and vocational family and consumer sciences programs; identification of types of programs; program planning, program evaluation and vocational counseling with emphasis on critical thinking and reflective decision-making. Credited only on B.S. in Education (Vocational Family and Consumer Sciences). A grade of "C" or better is required in this course. This course may not be taken pass/not pass.
CFS 601 Supervision of Student Teachers in Family and Consumer Sciences. 3(3-0) D. Prerequisite: teaching experience in Family and Consumer Sciences. Experience in creating an environment that will encourage Family and Consumer Sciences student teachers to realize their potentials and gain competence in teaching.
CFS 695 Advanced Technical Practice. 3(3-0) 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 696 Practicum. 4(4-0) D. Prerequisite: permission. The assumption of responsibilities at an approved practicum site under the direction of a CFS Professor and practicum site supervisor.

DEPARTMENT OF GEOGRAPHY, GEOLOGY, AND PLANNING

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GRADUATE FACULTY

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

MASTER OF SCIENCE, GEOSPATIAL SCIENCES IN GEOGRAPHY AND GEOLOGY

Robert T. Pavlowsky, Graduate Director
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PROGRAM DESCRIPTION

The program of study is designed to provide professional training and develop scholarly analytical skills in Geospatial Science in the areas of Physical Geography and Environmental Geology. This program will develop a student's knowledge in several areas of departmental strength which include cartography, geographic information science, remote sensing, hydrology, water quality, geomorphology, climatology, watershed management, mineral exploration, geochemistry, geophysics, and geohydrology.

The department 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 management.

The core curriculum contains course work on GIS, Remote Sensing, statistical methods, 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 or Environmental Geology. If a student intends to pursue research outside these concentration areas, they should contact the program director and 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 Environmental 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 Core**

GEO 600	Introduction to Geospatial Sciences in Geography and Geology	1 hr
MTH 547	Applied Regression	3 hrs
GEO 601	Research Methods and Design in Geospatial Sciences	3 hrs
GRY 566	Advanced Geographic Information Systems	3 hrs
GRY 551	Remote Sensing	3 hrs
GEO 680	Seminar in Geospatial Sciences	2 hrs
		Total 15 hrs

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

   Thesis Option. A student can take 3-6 hours of GEO 699. 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 scientific reports for each project. The results of both research projects must be orally defended and their advisor and another graduate faculty member must approve written reports on the research projects. Non-thesis students should present at least one of these papers as part of course requirements of GEO 680. 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 core courses. Students choosing to complete a thesis may count 6 credit hours of GRY 699 or GLG 699 toward this 18 hour requirement. For all students, at least 17 credit hours of course work must be at the 600 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, an academic advisor, Graduate Program Director and student 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 Science Comprehensive Exam 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 two areas of research concentration for prospective students. Students are strongly encouraged to select a research topic in these concentration areas.

Physical Geography
Students interested in physical geography can select a research topic in geomorphology, watershed hydrology, watershed management, climatology or natural resource management. Students should integrate geospatial science with physical geography when doing either a thesis or non-thesis research project. Students selecting this concentration would take the following courses:

GRY 548 Fluvial Geomorphology
GEO 650 Advanced Climatology

And two additional courses from the following list:

GRY 535 Climatology and Global Climate
GEO 651 Topics in Advanced Physical Geography
GRY 560 Thematic Mapping
GRY 562 Introduction to Geographic Information Science
GRY 563 Analytical and Automated Geographic Information Science
GEO 670 Advanced Field and Laboratory Methods
GEO 655 Applications of Digital Cartography, Analytical Photogrammetry and Remote Sensing in Geospatial Sciences

Environmental Geology
Students interested in environmental geology can select a research topic in geohyrology or geochemistry. Students may integrate geospatial science with environment geology when doing either a thesis or non-thesis research project. Students selecting this concentration would take the following courses.

GLG 672 Geohyrology
GLG 680 Geochemistry

And two additional courses from the following list:

GLG 573 Engineering Geology
GLG 590 Applied Geophysics
GLG 540 X-Ray Mineralolgy
GLG 665 Selected Topic in Geology
AGA 545 Soil Survey and Land Appraisal
AGA 555 Soil Genesis, Morphology & Classification II

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 Cartographic Science, Geography and Geology may apply for early admission to the Master of Science in Geospatial Science. 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 work in Cartographic Science, Geography and Geology course work to complete a masters degree in three full semesters and one summer semester. Students can choose from GRY 566, GRY 551, GRY 580, MTH 547, GLG 573, GLG 590, GLG 672, 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 Cartographic Science, Geography or Geology 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 Cartographic Science and Geography must have completed GRY 561 and have a GPA of 3.25 in all geography 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 43.

MSAS Environmental Management Option:

Required (6 hours)

GEO 630 Environmental Assessment	3 hrs
ECO 540 Economics of the Environment	3 hrs

Elective hours (6 hours chosen in consultation with advisor)

BIO 532 Principles of Fisheries Management	3 hrs
BIO 562 Limnology	3 hrs
BIO 585 Game Management	3 hrs
BIO 626 Advanced Limnology Methods	3 hrs
CHM 615 Chemistry of Environmental Systems	3 hrs
PLN 671 Land Use Planning	3 hrs
PLN 574 Open Space & Recreation Planning	3 hrs
GRY 648 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. (See program requirements for the M.S.Ed., Secondary Education listed under "Graduate College: Interdisciplinary Programs".).

PREREQUISITE EARTH SCIENCE REQUIREMENTS

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

EARTH SCIENCE REQUIREMENTS

GLG 601	Earth Science for Sec. Teachers I	3 hrs
GLG 602	Earth Science for Sec. 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. (See program requirements for the M.S.Ed., Secondary Education under "Graduate College: Interdisciplinary Programs".)

PREREQUISITE GEOGRAPHY REQUIREMENTS

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

GEOGRAPHY REQUIREMENTS

GRY 600	Cultural Geo. for Sec. Teachers I	3 hrs
GRY 603	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. (See program requirements for the M.S.Ed., Secondary Education listed under "Graduate College: Interdisciplinary Programs".)

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 600 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 Unites 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 University of Missouri-Rolla (UMR) and the Department of Geography, Geology and Planning at Missouri State University. Faculty members from UMR 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 UMR 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. The certificate will initially be awarded by the Geological Engineering program in the Department of Geological Sciences and Engineering at UMR.

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 the 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 UMR and two courses from those offered by Missouri State. 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:

UMR 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:

GRY 551	Remote Sensing
GRY 561	Intro. to Geographic Information Science
GRY 562	Internet Geospatial Science
GRY 563	Analytical & Automated Geog. Info. Sci.
GRY 566	Advanced Geographic Information Science
GRY 655	App. of Digital Cartography, Analytical Photogrammetry & Remote Sensing

Other courses approved by the UMR and Missouri State 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 523 Coastal Marine Geology. 2(2-0) Su. Prerequisites: undergraduates: 6 credit hours of geology; graduates: 12 credit hours of geology. Must be taken at Gulf Coast Research Laboratory, Ocean Springs, Mississippi. Fees are set at the rate for legal residents of Mississippi. A study of inshore and near-shore geologic processes, sedimentation patterns, and landform development.

GLG 524 Coastal Marine Geology Lab. 1(0-2) Su. Prerequisite: concurrent enrollment in GLG 523. Laboratory portion of GLG 523. Field and laboratory activities. Concurrent enrollment in GLG 523 required.

GLG 530 Optical Mineralogy. 3(1-4) D. Prerequisites: 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.

GLG 540 X-ray Mineralogy. 3(1-4) D. Prerequisite: GLG 332 or permission of instructor. 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.

GLG 570 Principles of Stratigraphy. 4(3-2) F. Prerequisites: 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.

GLG 581 Geochemical Techniques. 4(2-4) SE. Prerequisites: GLG 332; and either MTH 135 or MTH 138 or equivalent; or permission of instructor. Geochemical techniques and procedures used in ore exploration, point and non-point contamination and other environmental studies. Analysis of trace elements in rocks, soils, plants, and waters using inductively coupled plasma methods. Also use of GPS to locate sample sites and a review to prepare maps. Field trips required.

GLG 590 Applied Geophysics. 3(2-2) S. Prerequisites: GLG 340 (or permission of instructor); and either PHY 124 or PHY 204 (or concurrent enrollment in either); and either MTH 280 or MTH 288 (or concurrent enrollment in either). 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.

GLG 597 Selected Topics in Geology. 1-5 D. Prerequisite: permission of instructor. Detailed treatment of various advanced topics in geology which may vary from year to year. Some typical topics: geologic instrumentation, selenology, sedimentology, and crystallography. Since credit and topics vary, the course may be repeated for a maximum of 6 hours. Variable content course.
GLG 601 Geology for Secondary Teachers I. 3(2-2) D. Prerequisite: permission of department head. Earth materials, earth processes, geological history, and the geological environment.
GLG 602 Geology for Secondary Teachers II. 3(2-2) D. Prerequisite: permission of instructor. Continuation of GLG 601.
GLG 613 Field Geology for Secondary Teachers. 1-3 D. Prerequisite: permission of instructor. 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. Course may be repeated to a total of 6 hours when destination varies.
GLG 651 Seminar in Geology. 2(2-0). Prerequisite: permission of department head. Preparation of an extensive paper on selected topics to be read before staff seminars. Satisfies requirements for Option II (seminar) for the Master of Science in Secondary Education.
GLG 665 Selected Topics in Earth Science. (Identical to GRY 640.) 3(2-2) F, S. 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. Since topics vary, the course may be repeated for a total of six hours. Variable content course.
GLG 672 Geohydrology. 3(2-2) S. Prerequisites: GLG 314; and either MTH 261 or MTH 287; or permission of instructor. 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. Students cannot receive credit for both GLG 472 and GLG 672.
GLG 673 (573) Engineering Geology. 3(2-2) SE. Prerequisites: GLG 333, and either MTH 261 or MTH 287; and either PHY 123 or PHY 203. 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. Taught concurrently with GLG 473. Students cannot receive credit for both GLG 473 and GLG 673.
GLG 680 Geochemistry. 3(2-2) F. Prerequisites: GLG 332 and either MTH 135 or MTH 138; or permission of instructor. 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. Students cannot receive credit for both GLG 480 and GLG 680.
GLG 698 Research in the Geological Sciences. 1-3 D.
Prerequisite: permission of department head. Original research supervised by the geology staff, involving special areas of the geological sciences. May be repeated to a total of 5 hours.
GLG 699 Thesis. 1-6. Prerequisite: permission of department head. Independent research and study connected with preparation of thesis.

GEOGRAPHY COURSES

GRY 507 Geography of Subsaharan Africa. 3(3-0) S.
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 enrolled for graduate credit are required to complete two research projects. Students enrolled for undergraduate credit are required to complete one research project.
GRY 510 Tourism and Sustainability. 3(3-0) S. Prerequisite: GRY 310 or permission of instructor. 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.
GRY 535 (335) Climatology and Global Climate. 3(3-0) D. Prerequisite: GRY 135. Global climatological data and principles of biological, sociological and climatology and climatological methods. Causes and impacts of economic problems, climate and climate change.
GRY 548 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.
GRY 551 (661) Remote Sensing. 3(2-2) S. Prerequisite: GRY 360 or GLG 351. Introduction to environmental studies through the application of remotely sensed imagery and geospatial technologies. The course covers principals 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.
GRY 552 Photogrammetry. 3(1-4) S. Prerequisite: permission of instructor. Course covers basic concepts of photogrammetry through the utilization of aerial photographs and digital imagery to obtain accurate stereo models for topographic maps. Laboratory emphasizes geospatial stereo feature extraction using 3D digital displays.
GRY 553 Analytical Photogrammetry and Digital Cartography. 2(0-4) S. Prerequisite: GRY 552 or permission of instructor. Individualized instruction on the analytical stereoplotter-digitizer-interactive graphics editing system.
GRY 560 Thematic Mapping. 3(2-2) D. Prerequisite: GRY 363 or permission of instructor. Special purpose mapping of chosen topics. Emphasis will be on good graphic communication by means of maps.
GRY 561 (RPL 562) Introduction to Geographic Information Science. 3(2-2) S. Prerequisite: GRY 363 or permission of instructor. Basic principles and applications of Geographic Information Systems (GIS). Examines the nature and accuracy of spatially referenced data, as well as methods of data capture, storage, retrieval, visualization and output.
GRY 562 Internet Geospatial Science 3(2-2) F. Prerequisite: GRY 363 and GRY 561 or permission of instructor. 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.
GRY 563 Analytical and Automated Geographic Information Science. 3(2-2) S. Prerequisite: GRY 363, RPL 561, and either CIS 202 or CSC 121 or CSC 125, or permission of instructor. 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.
GRY 566 (RPL) Advanced Geographic Information Science. 3(2-2) F. Prerequisite: GRY 561. A theoretical and practical examination of analytical methods used in GIS, including vector and raster models, spatial overlay, incorporation of field data, analysis of surfaces, interpolation, TINs, and network analysis.

GRY 575 Satellite Surveying and Navigation. 3(1-4) F. Prerequisite: GRY 363 or permission of instructor. Theory and operation of satellite-based positioning systems. Includes mission planning, measurement of point, line and area features, differential correction techniques and waypoint navigation. Field trips required.
GRY 596 Topical Issues in Education. 1-5 D. Prerequisite: permission of department head. 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 maximum of 5 hours credit.
GRY 597 Special Topics in Geography. 1-5 D. Prerequisite: permission of instructor. Selected topics in geography. Selected 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. May be repeated to a maximum of 6 hours credit. Variable content course.
GRY 599 Research in Geography. 1-3 F, S. Prerequisite: permission of instructor. Enrichment through guided but independent, original research in geography and geography-related subject areas. Repeatable for a total of 6 credit hours.
GRY 600 Cultural Geography for Secondary Teachers I. 3(2-2). 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, and other current curriculum materials.
GRY 603 Cultural Geography for Secondary Teachers II. 3(2-2). Prerequisite: GRY 600. Continuation of GRY 600. Contemporary problems in land use, urbanization, and planning for optimum use of resource methods and materials of the high school geography project, and other current curriculum materials.
GRY 630 Weather Elements for Secondary Teachers. 3(3-0). 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 640 Selected Topics in Earth Science. (Identical to GLG 665). 3(2-2) S. 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.
GRY 648 Physiography and Resource Conservation. 3(2-2). Land forms, 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 699 Thesis. 1-6. Prerequisite: permission of department head. Independent research and study connected with preparation of thesis.

GEOSPATIAL SCIENCE COURSES

GEO 600 (RPL) Introduction to Geospatial Science. 1(1-0). F. Orientation to Geospatial Sciences and development of a research topic. Discussion of current issues revolving around the concepts of renewable and non-renewable resources in a cultural and physical framework.
GEO 601 (RPL) Research Methods in Geospatial Science. 3(2-2) S. Prerequisite: MTH 340 or permission of instructor. Methods of collecting, organization, and analyzing data pertinent to Geospatial Science. Emphasis will be on developing research strategies and quantitative analyses where appropriate.
GEO 630 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.
GEO 650 Advanced Climatology. 3(2-2). D. Advanced study of climate processes and climate change. Emphasis on the measurement and estimation of climatic variables, climatic models, and advanced statistical analysis of climate data. Past, present and future climate variability and change, climatic impact and adaptation assessment.
GEO 651 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 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 biogenography. Field trips may be required.
GEO 655 (RPL) Applications of Digital Cartography, Analytical Photogrammetry, and Remote Sensing. 1-3 D. Prerequisite: CRY 551 (661) or GRY (GLG 552 or BRY 566 or permission of instructor. Advanced application of aerial photography and digital imagery, analytical photogrammetry, remote sensing, and 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 670 (GRY) 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 680 (GRY) Seminar in Geospatial Sciences. 2(2-0). S. Prerequisite: permission of department head. Extensive paper on selected topic to be presented before staff seminars.

PLANNING COURSES

PLN 574 (CRP) Open Space and Recreation Planning. 3(2-2) S. Prerequisite: permission of instructor. 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.
PLN 576 CRP) Site Planning Studio. 4(2-4) F. Prerequisite: permission of instructor. 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.
PLN 596 (CRP) Research in Planning. 1-3 F, S. Prerequisite: permission of instructor. Enrichment through guided but independent, original research in planning and planning related subject areas. May be repeated for up to 6 credit hours.
PLN 597 (CRP) Selected Topics in Planning. 1-5. D. Prerequisite: permission of instructor. 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. Since topics vary, the course may be repeated for a maximum of 6 hours. Variable content course.
PLN 599 (CRP) Internship in Urban and Regional Planning. 1-3 F, S. Prerequisite: 90 hours and PLN 271 or CRP 271 and permission of instructor. Work in a community or regional planning agency. Students are monitored by faculty and supervisory personnel of the planning agency. May be repeated up to a maximum of 6 hours.
PLN 604 Community Resource Planning. 1-3 D. Prerequisite: permission of instructor. Explanations 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.
PLN 605 (CRP) (505) Social Planning. 3(3-0) S. Prerequisite: 30 hours or permission of instructor. This course will address planning issues as they relate to social policy and the provision of social welfare. This 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. Course could be taught simultaneously with PLN 405 and students cannot receive credit for both courses.

PLN 670 (CRP) (570) Planning Law. 3(3-0) S. Prerequisite: PLN 271 or permission of instructor. Study of the legal foundations of land use controls. Topics include historical legal cases establishing government intervention in private development, zoning, subdivision, growth management, individual liberty, environmental regulation, and the general welfare concept. Course could be taught simultaneously with PLN 470 and students cannot receive credit for both courses.

PLN 671 (CRP) (571) Land Use Planning. 3(3-0) F. Prerequisite: PLN 271 or CRP 271 or RIL 266 or permission of instructor. Focuses on conceptual and analytical techniques of land use planning including land use analysis, planning studies or procedures, and synthesis of planning elements through comprehensive plan development. Course could be taught simultaneously with PLN 471 and students cannot receive credit for both courses.

PLN 672 (CRP) (572) Community Planning Practicum. 4(3-2) S. Prerequisite: PLN 271 or CRP 271 or RIL 266 or permission of instructor. Focuses on the process of plan preparation and is intended to provide experience in 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 preparing a final report. Field problems will vary. Course could be taught simultaneously with PLN 472 and students cannot receive credit for both courses.

DEPARTMENT OF MATHEMATICS

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GRADUATE FACULTY

Professor: Richard G. Belshoff, Larry N. Campbell, Yungchen Cheng, Kanghui Guo, Shouchuan Hu, Paula A. Kemp (Distinguised Professor), 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, Changbing Hu, 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 600 level mathematics courses. At least one of the following four courses must be completed:

   MTH 602 Real and Abstract Analysis
   MTH 632 Abstract Algebra II
   MTH 622 Theory of Ord. Differential Equat. II
   MTH 642 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.

5. **Research Requirements.** 1-6 semester hours of course work from MTH 691, 692, 698, or 699, 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 500/600 level mathematics courses taken after admission into the program may be given credit for both undergraduate and graduate programs. The courses MTH 503, MTH 532, MTH 533, and MTH 540 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. John Kubicek. (See program requirements for the M.S.Ed., Secondary Education under "Graduate College Interdisciplinary Programs".)

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 600 or above.

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

Contact Dr. Tamera Jahnke. (See program requirements for the M.S.Ed., Secondary Education under "Graduate College: Interdisciplinary Programs".)

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 600 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 503 Advanced Calculus I. 3(3-0) F. Prerequisite: MTH 302 and MTH 315. Concepts of limit, continuity, differentiation, Riemann integration, sequences and series, and other related topics.
MTH 504 Advanced Calculus II. 3(3-0) D. Prerequisite: MTH 503. A continuation of MTH 503, including sequences and series of functions, uniform convergence, multivariate calculus, and other selected topics.
MTH 506 Theory of Functions of a Complex Variable. 3(3-0) D. Prerequisites: MTH 302 and MTH 315. Theory of elementary functions (polynomial, trigonometric, exponential, hyperbolic, logarithmic) of a complex variable, their derivatives, integrals, power series, other selected topics.
MTH 507 Introduction to Partial Differential Equations. 3(3-0) D. Prerequisites: 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.
MTH 532 Introduction to Abstract Algebra. 3(3-0) F. Prerequisites: MTH 302 and MTH 315. Theory of groups, rings, integral domains, fields, polynomials.
MTH 533 Linear Algebra I. 3(3-0) F, S. Prerequisites: MTH 302 and MTH 315. Vector spaces, linear independence, inner product spaces, linear transformations, eigenvectors, diagonalization.
MTH 534 Linear Algebra II. 3(3-0) D. Prerequisites: MTH 533. 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.
MTH 536 Theory of Numbers. 3(3-0) D. Prerequisites: MTH 302 and MTH 315. Factorization, Euler totient function, congruences, primitive roots, quadratic residues, and reciprocity law.
MTH 537 Applied Abstract Algebra. 3(3-0) D. Prerequisite: MTH 532 or MTH 533. 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.

MTH 540 Statistical Theory I. 3(3-0) F. Prerequisites: MTH 302 and MTH 315. Random variables, discrete and continuous probability functions, expectation, moment-generating functions, transformation of variables.
MTH 541 Statistical Theory II. 3(3-0) S. Prerequisite: MTH 540. Estimation, complete and sufficient statistics, maximum likelihood estimation, hypothesis testing, nonparametric statistics.
MTH 543 Stochastic Modeling. 3(3-0) S. Prerequisite: MTH 540. 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. **MTH 545 Applied Statistics.** 3(3-0) F. Prerequisite: 60 credit hours and either MTH 135 or MTH 138. 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.
MTH 546 Analysis of Variance and Design of Experiments. 3(3-0) S. Prerequisite: MTH 345 or MTH 541 or MTH 545 or permission of the department head. Topics include analysis of variance, estimation of variance components, randomized incomplete blocks, Latin squares, factorial, nested, split-plot designs, fixed, random, and mixed models.
MTH 547 Applied Regression Analysis. 3(3-0) D. Prerequisite: MTH 345 or MTH 541 or MTH 545 or permission of the department head. Topics include fitting a straight line, matrix models, residuals, selecting best equation, multiple regression, and non-linear estimation.
MTH 548 Applied Time Series Analysis. 3(3-0) F. Prerequisite: MTH 345 or MTH 541 or MTH 545 or permission of department head. 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.
MTH 567 Introduction to Non-Euclidean Geometry. 3(3-0) S. Prerequisites: MTH 302 and MTH 315. Development of non-Euclidean geometries; intensive study of hyperbolic geometry.
MTH 570 Combinatorial Analysis. 3(3-0) D. Prerequisite: MTH 280. An introduction to combinatorial analysis including enumeration methods, combinatorial identities with applications to the calculus of finite differences and difference equations.
MTH 575 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.
MTH 580 Applied Mathematics. 3(3-0) F. Prerequisite: MTH 303 and MTH 533 or permission of the department head. 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.
MTH 582 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.
MTH 596 Readings. 1-3 F, S. Prerequisites: permission of the department head. Periodic conferences with an advisor are required. May be repeated to a total of 6 hours.
MTH 601 Real Analysis. 3(3-0) D. Prerequisite: MTH 503. 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 L^P spaces.
MTH 602 Real and Abstract Analysis. 3(3-0) D. Prerequisite: MTH 601. A study of the theory of abstract measures and integration, and an introduction to functional analysis.
MTH 606 Complex Analysis. 3(3-0) D. Prerequisite: MTH 503. 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 610 Contemporary Mathematics for Secondary Teachers. 3(3-0). Prerequisites: Either MTH 532 or MTH 533; and either MTH 460 or MTH 567. Reports, research, and recent trends in secondary mathematics; recently developed programs in algebra and geometry.
MTH 621 Theory of Ordinary Differential Equations I. 3(3-0) D. Prerequisites: MTH 303 and MTH 503. 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 622 Theory of Ordinary Differential Equations II. 3(3-0) D. Prerequisite: MTH 621. 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 630 Abstract Algebra. 3(3-0) D. Prerequisites: MTH 532 and MTH 533. Topics from group theory will include Cayley's Theorem, finite abelian groups, Cauchy's Theorem, the Sylow Theorems, and free groups.
MTH 632 Abstract Algebra II. 3(3-0) D. Prerequisite: MTH 630. Topics from ring theory will include the Chinese Remainder Theorem, Euclidean domains, rings of fractions, PIDs and UFDs, and polynomial rings. Topics from field theory will include splitting fields, Galois theory, separability, normality, and finite fields.
MTH 641 Statistical Inference I. 3(3-0) D. Prerequisite: MTH 541. 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 642 Statistical Inference II. 3(3-0) D. Prerequisite: MTH 641. 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 681 Topology. 3(3-0) D. Prerequisite: MTH 503 or MTH 582. Point set topology in abstract spaces.
MTH 691 Seminar I. 2(2-0) D.
MTH 692 Seminar II. 2(2-0) D.
MTH 697 Topics. 3(3-0). 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 698 Research. 1-6 F, S. Supervised research in special areas of mathematics. May be repeated. May not be counted toward a Master of Science in Education degree.
MTH 699 Projects. 1-6 D. Independent research for thesis preparation.

DEPARTMENT OF PHYSICS, ASTRONOMY AND MATERIALS SCIENCE

Pawan Kumar Kahol, Department Head
Kemper Hall, Room 101; Phone (417) 836-5131
Fax (417) 836-6226; Physics@missouristate.edu

GRADUATE FACULTY

Professor: Ryan E. Giedd, Shyang Huang, Robert A. Mayanovic, Robert S. Patterson, Pawan K. Kahol, Kandiah Manivannan, Emmett R. Redd, Robert J. Whitaker, George W. Wolf
Associate Professor: Kartik C. Ghosh, Michael D. Reed
Emeritus Professor: Lawrence E. Banks, Jr., James G. Broerman, Bruno Schmidt

MASTER OF SCIENCE, MATERIALS SCIENCE

Kartik Ghosh, Graduate Director
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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 <u>full standing</u> 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 698 Seminar course.

For students who are not graduate assistants, evaluation will be done in the MAT 698 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 575 Introduction to Quantum Mechanics is required.
2. Required core:
   MAT 540 Thermodynamics of Materials
   MAT 550 Introduction to Materials Science
   MAT 580 Structure of Solids
   MAT 650 Experimental Design
   MAT 660 Experiments in Physical Characterization
   MAT 670 Vapor Synthesis of Materials
3. Six hours, with at least 3 hours at the 600 level or above, chosen from the following:
   PHY 543 Kinetic Theory and Statistical Mechanics
   PHY 553 Electromagnetic Field Theory
   MAT 620 Advanced Quantum Mechanics
   MAT 658 Optoelectronic Materials
   MAT 680 Polymer Preparation & Characterization
   MAT 690 Statistical App. in Materials Science

   Interdisciplinary Courses approved by the department head for elective credit. Examples: BMS 514, Scanning Electron Microscopy or CHM 514 Polymer Chemistry
4. Seminar. 1 hour of seminar, MAT 698.
5. Research. 9-12 hours of research, MAT 699 (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:

- Obtain admission to the Master of Science in Materials Science accelerated program by applying to the Graduate College prior to their senior year.
- 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 540, MAT 550 and MAT 580.

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 "Graduate College: Interdisciplinary Programs".

PHYSICS REQUIREMENTS

Physics course work with a minimum of 3 hours in courses numbered 600 or above. **Total 15 hrs**

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

Contact Dr. Tamera Jahnke. (See program requirements for the M.S.Ed., Secondary Education under Graduate College Interdisciplinary Programs).

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 600 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 513 Solar and Extra-Solar Systems. 3(3-0) FO. Prerequisite: AST 114 or AST 115, MTH 303 or equivalent, or permission. Formation of planetary systems, planetary dynamics, and comparative planetology. Project required. Student cannot receive credit for both AST 313 and AST 513.
AST 515 Stellar Structure and Evolution. 3(3-0) SO. Prerequisite: AST 114 or AST 115, MTH 303 or equivalent, or permission. Basic concepts of stellar structure, atmospheres, and evolution. Project required. Student cannot receive credit for both AST 315 and AST 515.
AST 517 Galaxies and Cosmology. 3(3-0) SE. Prerequisite: AST 114 or AST 115, MTH 303 or equivalent, or permission. 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. Student cannot receive credit for both AST 317 and AST 517.
AST 611 Astronomy for Teachers. 3(2-2). Theory and techniques of observational astronomy.

PHYSICS COURSES

PHY 501 Physics and Astronomy By Inquiry. 2(1-2) F. Prerequisite: 70 hours, including 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 toward a major or minor in physics.
PHY 509 Special Topics in Physics and Astronomy. 1-3 D. Variable content, variable credit course. Topics to be chosen from current areas of interest. May be repeated up to 6 hours with different topics.
PHY 524 Digital Signal Processing. 4(2-4) S. Prerequisites: 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.
PHY 533 Advanced Mechanics. 3(3-0) D. Prerequisites: 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.
PHY 543 Kinetic Theory and Statistical Mechanics. 3(3-0) D. Prerequisite: PHY 343, 375, and 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.
PHY 553 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.
PHY 558 Physics of Semiconductor Devices. 3(3-0) F. Prerequisites: PHY 352, 375, 391, or permission. Topics will be selected from: band structure and electron statistics in semiconductors, doping and carrier transport in homogeneous materials, p-n junction and its characteristics under bias, bipolar devices, unipolar devices, MOSFETs, light-emitting diodes, semiconductor lasers, and integrated circuits.
PHY 575 Quantum Mechanics. 3(3-0) F. Prerequisites: PHY 333 and PHY 476. 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.
PHY 590 Applied Group Theory. 3(3-0) D. Prerequisite: PHY 333; PHY 533 and MTH 533 recommended. 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.
PHY 601 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 credit hours provided the topics are different.
PHY 685 Physics Laboratory for Teachers. 3(1-4) D. Prerequisite: permission. Performance and analysis of secondary laboratory experiments in physics.
PHY 690 Seminar in Physics. 2(2-0) D. Prerequisite: permission. Extensive paper on agreed topic in physics to be read before staff seminars. May be repeated to total 4 hours.
PHY 699 Research in Natural and Applies Science. 1-6 D. Prerequisite: permission. 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 Material Science.

MATERIALS SCIENCE COURSES

MAT 509 Special Topics in Materials Science. 1-3 D. Prerequisite: permission of instructor. Variable content, variable credit 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.

MAT 540 Thermodynamic of Materials. 3(3-0) F. Prerequisite: PHY 343, CHM 506, or permission. Review of classical thermodynamics, equilibrium in thermodynamic systems, the statistical interpretation of entropy, unary and multi-component system, thermodynamics of phase diagrams and phase equilibrium.

MAT 550 Introduction to Materials Science. 3(3-0) F. Prerequisite: PHY 375, CHM 507, or permission. 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.

MAT 580 Structure of Solids. 3(3-0) F. Prerequisite: PHY 375, CHM 507, or permission. 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.

MAT 620 Advanced Quantum Mechanics. 3(3-0) S. Prerequisite: PHY 575. 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 650 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 658 Optoelectronic Materials. 3(3-0) S. Prerequisite: MAT 580. Course includes the study of advanced electronic properties of materials, lattice dynamics, and a survey of the optical-electronic interactions in materials.

MAT 660 Experiments in Physical Characterization. 3(1-4) S. Prerequisite: MAT 550 and MAT 580. 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 670 Vapor Synthesis of Materials. 3(1-4) S. Prerequisite: MAT 550 and MAT 540. 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 680 Polymer Preparation and Characterization. 3(1-4) S. Prerequisite: MAT 550 and MAT 660. 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 690 Statistical Applications in Materials Science. 3(3-0) S. Prerequisite: MAT 550 or permission. 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 698 Seminar in Materials Science. 1, S. Prerequisite: permission of instructor. 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 699 Research in Materials Science. 1-6, D. Prerequisite: permission of instructor. Supervised research in areas of materials science. May be repeated, but no more than 12 hours may be counted towards the degree.