College of Sciences

The natural and mathematical sciences represent the dual cutting edges of our technological future. UNLV's College of Sciences is dedicated to making this future real, in the creation of new knowledge through research, and in the application of that knowledge in the classroom and in the development of technological advances to benefit society. These are the guiding principles that bring students, faculty, and staff together. Whether in a small discussion session, in a research laboratory or in the field, College of Sciences graduate students are in an environment in which learning, discovery, and innovation are the common goals. Many students choose a graduate institution based on the reputation of an individual faculty scholar or laboratory group. This is often an excellent approach to find the right match between a new graduate student and a mentor. Still, students who come to UNLV's College of Sciences without a particular graduate project in mind can count on identifying potential major professors who are receptive to a wide array of interests and backgrounds. Through its active programs of research and teaching, the College of Sciences has established a remarkable foundation of state-of-the-art instrumentation and facilities, providing an ever-growing set of opportunities for students who desire the best from their graduate experiences. Students who graduate with a Master's or doctoral degree from the College of Sciences fulfill their professional goals, and are competitive for career positions in academia, industry, or in governmental or non-governmental organizations.

Timothy L. Porter, Dean
Javier A. Rodriguez, Associate Dean

College of Sciences Plan

Master of Arts – Science

Plan Description

The Master of Arts in Science (M.A.S.) is a non-thesis degree designed to allow students to increase their knowledge base in two different fields of science. Traditional and nontraditional students interested in pursuing or advancing science-related careers will discover a host of new opportunities after completing the program. Secondary science teachers who enroll in the program will be better prepared to face classroom challenges with a broad science background.

This program includes the current graduate faculty, course work and facilities from the departments of Biological Sciences, Chemistry, Geoscience, Mathematical Sciences, and Physics. Any graduate courses offered by these departments can be considered for inclusion in this degree program. In addition, graduate courses from Environmental Studies can be used to satisfy the second field.

Learning Outcomes

http://www.unlv.edu/degree/ma-science

Plan Admission Requirements

All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements.

Three letters of recommendation are required from individuals familiar with the applicant's academic and professional record and potential for advanced study in mathematics and science education.

A written statement/letter of intent is required and should include:

summary of research interests
reason(s) for wishing to earn an advanced degree
motivation for attending UNLV
name of two intended department faculty mentors for major and minor

Submission of official transcripts of all colleges and universities attended.

Copy of current curriculum vitae or resume is required.

Teacher Track

A bachelor's degree in any of the sciences, mathematical sciences or secondary education with at least nine upper division (300 level or higher) science or math courses. Must be a licensed educator, have current licensure, a current job offer (ideally in grades 6-12) or degree in education.

A minimum grade point average (GPA) of 3.0 for all undergraduate work (based on a 4.00 scale).

Satisfactory scores on the General Graduate Record Examination (GRE). Successful applicants should complete the GRE or pass the Praxis I, II.

Copy of current teaching licensure, licensure certificate, letter of employment or diploma is required.

General Track

Satisfactory scores on the General Graduate Record Examination (GRE).

Plan Requirements

See Subplan Requirements below.

Subplan 1 Requirements: Teacher Track

Total Credits Required: 33

Course Requirements

- Major Field Courses - Credits: 9
  - Complete 9 credits of advisor-approved coursework in a major field of study from the following list:
    - Biology
    - Chemistry
    - Physics
    - Astronomy
    - Mathematics
    - Statistics
    - Geoscience
    - Water Resources Management
- Minor Field Courses - Credits: 6
  - Complete 6 credits of advisor-approved coursework in a minor field of study from the following list:
    - Biology

        - Chemistry
        - Physics
        - Astronomy
        - Mathematics
        - Statistics
        - Geoscience
        - Water Resources Management
- Elective Courses - Credits: 15
    - Complete 15 credits of advisor-approved elective coursework.
- Culminating Experience - Credits: 3
    - Complete either the capstone course or professional paper.
        - SCI 796 - Professional Paper, Master of Arts in Sciences

Degree Requirements

See Plan Degree Requirements below.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 2 Requirements: General Track

Total Credits Required: 33

Course Requirements

- Major Field Courses - Credits: 9
    - Complete 9 credits of advisor-approved coursework in a major field of study from the following list:
        - Biology
        - Chemistry
        - Physics
        - Astronomy
        - Mathematics
        - Statistics
        - Geoscience
        - Water Resources Management
- Minor Field Courses - Credits: 6
    - Complete 6 credits of advisor-approved coursework in a minor field of study from the following list:
        - Biology
        - Chemistry
        - Physics
        - Astronomy
        - Mathematics
        - Statistics
        - Geoscience
        - Water Resources Management

- Elective Courses - Credits: 15
    - Complete 15 credits of advisor-approved elective coursework.
- Culminating Experience - Credits: 3
    - Complete either the capstone course or professional paper.
        - SCI 796 - Professional Paper, Master of Arts in Sciences

Degree Requirements

See Plan Degree Requirements below.

Graduation Requirements

See Plan Graduation Requirements below.

Plan Degree Requirements

Complete a total of 33 credits of regular course work of which 50% must be at 700-level.
A student will be placed on academic probation if a minimum 3.00 grade point average is not maintained in all work taken in the degree program.
Students accepted into the Master of Arts in Science (MAS) program will be required to take at least 12 credits in one major area of one department and at least 6 credits in one minor field of science, mathematics or statistics from a different department in the College.
No more than 9 credits may be earned through independent study.
A maximum of 6 credits may be taken outside of the College.
Students must obtain advisor approval for all coursework. Coursework can be taken from Biology, Chemistry, Physics, Astronomy, Mathematics, Statistics, Geoscience, Science, Environmental Studies, Educational Psychology, Anthropology, Water Resource Management, Civil and Environmental Engineering, Electrical Engineering, Computer Science, Mechanical Engineering, Curriculum and Instruction.
All students must develop their degree program with the consent of the faculty mentor from their major department and the student's Graduate Advisory Committee. Student's progress will be assessed annually by the Advisory Committee.
Students must successfully complete a professional paper.

Plan Graduation Requirements

The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
The student must complete a culminating experience.

College of Sciences Courses

SCI 620 - Middle School Mathematics Content:
Credits 1–3
Middle school mathematics content for teachers. Topics: a) Number, Number Theory, Operations, b) Geometry & Measurement, c) Probability & Statistics, d) Algebra I, e) Euclidean/Non-Euclidean Geometry, f) Problem Solving, g) Algebra II, h) Pre-calculus, i) Computer/Technology Applications, j) other. **Notes** Credit repeatable by topic (1–3 credits). Credits may not be applied to College of Sciences graduate program. The maximum number of credits that may be earned is 24.

SCI 630 - Middle School Science Content:
Credits 1–3
Surveys middle school science content for middle school teachers. Introduces experimental and research-based aspects of the fields/topics listed through an inquiry approach to scientific content. Fields/topics: a) Lab Safety and Science Process. b) Life Science IA. c) Life Science IB. d) Physical Science IA. e) Physical Science IB. f) Earth Science IA. g) Earth Science IB. h) other. **Notes** May be repeated for credit in different fields/topics (1–3 credits); not available for credit in graduate programs in College of Sciences

SCI 640 - High School Mathematics Content:
Credits 1–3. **Formerly** Surveys high school mathematics content for high school teachers. Introduces exploratory and research-based aspects of the fields/topics listed through a problem solving approach to mathematics content. Fields/topics: a) Geometry. b) Advanced Algebra. c) Trigonometry and Analysis. d) Statistics and Probability. e) Calculus. f) Technology Applications. g) other. **Notes** May be repeated for credit in different fields/topics (1–3 credits); not applicable to graduate programs in College of Sciences.

SCI 650 - High School Science Content:
Credits 1–3
High school science content for teachers. a) Lab Safety, Science Process. b) Content Area Literacy. (c,d) Biology IA, IB (e,f) Earth Science IA, IB (g,h) Chemistry IA, IB (j,k) Physics IA, IB (l) AP Biology (m) AP Chemistry (n) AP Physics (o) other (p,q) Principles of Science, semesters 1,2.

SCI 691 - Life Science for Federal Land Managers
Credits 1–3
For managers in BLM, BIA, Forest Service, Park Service and Fish and Wildlife Service. Meets GS 401 Certification needs. Conceptual understanding of basic biological principles: how information is acquired and evaluated within a scientific framework; modern cell theory; basic principles of molecular biology and genetics; and concepts of microevolution.

SCI 796 - Professional Paper, Master of Arts in Sciences
Credits 1–3
Professional paper preparation, including review of literature or similar research effort. May be repeated to a maximum of three credits. Not permitted for students pursuing the M.S. Thesis option. Prerequisite: Consent of instructor.

Chemistry

The Chemistry Department offers the Ph.D. in Chemistry or Radiochemistry and the M.S. in Chemistry or Biochemistry. Students may supplement their programs with appropriate courses from other science departments, with the approval of their graduate committee. Research may include projects conducted in the Chemistry Department, the Harry Reid Center, the Desert Research Institute, or the Environmental Protection Agency.

For additional information contact: Kathleen A. Robins (Graduate Coordinator) at (702) 895-3510. Web address: can be accessed through the UNLV home page at http://sciences.unlv.edu/Chemistry/prospgrads.htm

David Hatchett, Ph.D., Chair
Kathleen Robins, Ph.D., Graduate Coordinator

Chair

Hatchett, David W. - *Full Graduate Faculty*
Associate Professor; *Environmental & Analytical Chemsitry;* B.S., California State University, Stanislaus; Ph.D., University of Utah. *Rebel since 1999.*

Graduate Coordinator

Robins, Kathleen A. - *Full Graduate Faculty*
Associate Professor; *Physical Chemistry;* B.S., University of Illinois, Champaign-Urbana; M.A., Ph.D., University of California, Santa Barbara. *Rebel since 1991.*

Graduate Faculty

Abel-Santos, Ernesto - *Full Graduate Faculty*
Associate Professor; *Biochemistry;* B.S., Autonomous University of Santo Domingo, Dominican Republic; Ph.D., Washington University School of Medicine, St. Louis. *Rebel since 2006.*

Bhowmik, Pradip - *Full Graduate Faculty*
Associate Professor; *Organic & Polymer Chemistry;* M.S., University of Dhaka, Bangladesh; M.S., University of Massachusetts at Dartmouth; Ph.D., University of Massachusetts at Amherst. *Rebel since 1998.*

Czerwinski, Kenneth R. - *Full Graduate Faculty*
Associate Professor; *Radiochemistry;* B.A., Knox College; Ph.D., University of California, Berkeley. *Rebel since 2003.*

Gary, Ronald K. - *Full Graduate Faculty*
Associate Professor; *Biochemistry;* B.S., University of California, Irvine; Ph.D., Cornell University. *Rebel since 1999.*

Heske, Clemens - *Full Graduate Faculty*
Associate Professor; *Materials Chemistry;* Diploma, TH Darmstadt, Germany; Ph.D., University of Wurzburg, Germany. *Rebel since 2004.*

Hodge, Vernon F. - *Full Graduate Faculty*
Professor; *Environmental & Analytical Chemistry;* B.A., M.S., San Diego State University; Ph.D., University of California, San Diego. *Rebel since 1982.*

Kang, Jun Young
Assistant Professor, *Organic Chemistry*.

Kleiger, Gary - *Full Graduate Faculty*
Assistant Professor, *Biochemistry*.

Lee, Dong-Chan - *Full Graduate Faculty*
Assistant Professor; *Organic & Materials Chemistry;* B.S., M.S., Kyungpook National University, Korea; Ph.D., University of Massachusetts, Lowell. *Rebel since 2005.*

Lindle, Dennis W. - *Full Graduate Faculty*
Professor; B.S., Indiana University; Ph.D., University of California, Berkeley. *Rebel since 1991.*

Naduvalath, Balakrishnan - *Full Graduate Faculty*
Associate Professor; *Physical & Environmental Chemistry;* M.S., University of Calicut, India; Ph.D., Indian Institute of Technology, Kanpur. *Rebel since 2002.*

Orgill, MaryKay - *Full Graduate Faculty*
Assistant Professor; *Chemical Education;* B.S. Brigham Young University; M.S., Ph.D., Purdue University. *Rebel since 2003.*

Robins, Kathleen A. - *Full Graduate Faculty*
Associate Professor; *Physical Chemistry;* B.S., University of Illinois, Champaign-Urbana; M.A., Ph.D., University of California, Santa Barbara. *Rebel since 1991.*

Spangelo, Bryan L. - *Full Graduate Faculty*
Professor; *Biochemistry;* B.S., Keene State College; Ph.D., George Washington University Medical Center. *Rebel since 1994.*

Steinberg, Spencer - *Full Graduate Faculty*
Professor; *Environmental & Organic Chemistry;* B.A., Ph.D., University of California, San Diego. *Rebel since 1989.*

Sung, Hong - *Full Graduate Faculty*
Associate Professor, *Biochemistry*.

Tirri, Lawrence J. - *Full Graduate Faculty*
Assistant Professor; *Biochemistry;* B.S., Fairleigh Dickinson University; Ph.D., Fordham University. *Rebel since 1997.*

Zhang, Hui - *Full Graduate Faculty*
Associate Professor, Biochemistry.

Professors Emeriti

Alsup, William M.
Emeritus Associate Professor; B.S., M.E., Ph.D., University of Wyoming. *UNLV Emeritus 1964-1991.*

Billingham, Edward J., Jr.

Emeritus Professor; B.S., Lebanon Valley College; Ph.D., Pennsylvania State University. *UNLV Emeritus 1965-1988.*

Earl, Boyd
Professor; B.S., University of Idaho; M.S., Ph.D., University of California, Berkeley. *UNLV Emeritus 1976.*

Emerson, David W.
Emeritus Professor; B.A., Dartmouth College; M.S., Ph.D., University of Michigan. *UNLV Emeritus 1981-1998.*

Grenda, Stanley C.
Associate Professor; B.S., DePaul University; M.S., University of Arizona; Ph.D., Lehigh University. *UNLV Emeritus 1967.*

Titus, Richard L.
Emeritus Professor; B.A., DePaul University; Ph.D., Michigan State University. *UNLV Emeritus 1967-1997.*

Chemistry Plans

Master of Science - Chemistry

Plan Description

Our graduate programs offer exceptional research opportunities for advanced training in a wide variety of chemistry related disciplines including Organic, Physical, Analytical, Computational, Materials, Biochemistry, and Chemical Education. The graduate student to faculty ratio in the department is nearly one-to-one. Consequently, our diverse student body receives a high level of individualized interaction with excellent faculty through customized research projects, specialized course work, professional development, and graduate seminars. In addition, many of our research programs offer exciting interdisciplinary collaborations with local scientists, as well as with scientists nationally and internationally.

Learning Outcomes

www.unlv.edu/degree/ms-chemistry

Plan Admission Requirements

Admission to the program requires an undergraduate degree in chemistry, chemical engineering, biology, biochemistry or a related discipline, with a cumulative GPA of 2.75, or of 3.00 for the last two years of undergraduate work. An application must be submitted to the Graduate College, with official transcripts of all college-level work. Two letters of recommendation from individuals able to assess the applicant's potential as a graduate student should be sent directly to the department along with an additional set of transcripts. The GRE General Aptitude Test results must be received by the department prior to regular admission.

Individuals with apparent deficiencies in their undergraduate background may be required to enroll in selected courses in addition to those listed in the following section to satisfy M.S. degree requirements.

All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements.

Plan Requirements

Total Credits Required: 30

Course Requirements

- Graduate Seminar Course – Credits: 2
  - CHEM 791 - Graduate Seminar
- Elective Courses – Credits: 18
  - Complete 18 credits of elective coursework.
- Independent Study – Credits: 4
  - CHEM 795 - Independent Study
- Thesis – Credits: 6
  - CHEM 798 - Thesis

Degree Requirements

Students must complete a minimum of 30 credit hours with a minimum GPA of 3.00.

No grade lower than C is acceptable, and only one grade below B- is permitted.

At least 12 credits of electives must be in courses at the 700-level.

In consultation with his/her advisor, a student will organize a thesis committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.

Research and course work specializations are available in analytical chemistry, biochemistry, organic chemistry, and physical chemistry. The individual student's program of course work must be selected in consultation with and approved by the student's committee, and may include courses from selected disciplines other than chemistry, such as biology, physics, civil and environmental engineering, or water resources management.

Each student is required to present a departmental seminar on the student's research prior to graduation. This requirement is in addition to the two credits of Graduate Seminar. Students are expected to attend weekly departmental seminars.

Each student is required to meet at least once per semester with the student's examination committee. At the meeting in the semester prior to the expected term of graduation, the student will be asked to make a detailed presentation on research progress. The committee will then make recommendations to be addressed by the student during the remainder of the student's research program, in writing the thesis, and in the final examination. The committee may request another meeting prior to the final exam if deemed necessary.

It is expected that each student be a teaching assistant for a minimum of two courses prior to graduation. It is also expected that each student publish at least one research-based manuscript in a peer-reviewed journal.

Plan Graduation Requirements

The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.

The student must submit and successfully defend his/her thesis by the posted deadline. The defense must be advertised and is open to the public.

The student must submit his/her approved, properly formatted hard-copy thesis to the Graduate College, and submit the approved electronic version to ProQuest by the posted deadline.

Master of Science - Biochemistry

Plan Description

Our graduate programs offer exceptional research opportunities for advanced training in a wide variety of chemistry related disciplines including Organic, Physical, Analytical, Computational, Materials, Biochemistry, and Chemical Education. The graduate student to faculty ratio in the department is nearly one-to-one. Consequently, our diverse student body receives a high level of individualized interaction with excellent faculty through customized research projects, specialized course work, professional development, and graduate seminars. In addition, many of our research programs offer exciting interdisciplinary collaborations with local scientists, as well as with scientists nationally and internationally.

Learning Outcomes

www.unlv.edu/degree/ms-biochemistr

Plan Admission Requirements

Admission to the program requires an undergraduate degree in chemistry, chemical engineering, biology, biochemistry or a related discipline, with a cumulative GPA of 2.75, or of 3.00 for the last two years of undergraduate work. An application must be submitted to the Graduate College, with official transcripts of all college-level work. Two letters of recommendation from individuals able to assess the applicant's potential as a graduate student should be sent directly to the department along with an additional set of transcripts. The GRE General Aptitude Test results must be received by the department prior to regular admission.

Individuals with apparent deficiencies in their undergraduate background may be required to enroll in selected courses in addition to those listed in the following section to satisfy M.S. degree requirements.

All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements.

Plan Requirements

Total Credits Required: 30

Course Requirements

- Graduate Seminar Course – Credits: 2
    - CHEM 791 - Graduate Seminar
- Elective Courses – Credits: 18
    - Complete 18 credits of advisor-approved coursework electives. These courses may include but are not limited to:
        - CHEM 770 - Protein Chemistry
        - CHEM 771 - Metabolism and Energetics
        - CHEM 772 - Nucleic Acid Chemistry
        - CHEM 773 - Physical Biochemistry
        - CHEM 672 - Biochemistry Laboratory
        - BIOL 701 - Ethics in Scientific Research
- Independent Study – Credits: 4

    - CHEM 795 - Independent Study
- Thesis – Credits: 6
    - CHEM 798 - Thesis

Degree Requirements

Students must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
No grade lower than C is acceptable, and only one grade below B- is permitted.
At least 12 credits of electives must be in courses at the 700-level.
In consultation with his/her advisor, a student will organize a thesis committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.
Each student is required to present a departmental seminar on the student's research prior to graduation. This requirement is in addition to the two credits of Graduate Seminar. Students are expected to attend weekly departmental seminars.
Each student is required to meet at least once per semester with the student's examination committee. At the meeting in the semester prior to the expected term of graduation, the student will be asked to make a detailed presentation on research progress. The committee will then make recommendations to be addressed by the student during the remainder of the student's research program, in writing the thesis, and in the final examination. The committee may request another meeting prior to the final exam if deemed necessary.
It is expected that each student be a teaching assistant for a minimum of two courses prior to graduation. It is also expected that each student publish at least one research-based manuscript in a peer-reviewed journal.

Plan Graduation Requirements

The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
The student must submit and successfully defend his/her thesis by the posted deadline. The defense must be advertised and is open to the public.
The student must submit his/her approved, properly formatted hard-copy thesis to the Graduate College, and submit the approved electronic version to ProQuest by the posted deadline.

Doctor of Philosophy - Radiochemistry

Plan Description

The Radiochemistry Ph.D. Program is a student-driven research intensive program stressing fundamental aspects of radiochemistry science. It was established by the Departments of Health Physics and Chemistry and includes participants from the Harry Reid Center, Nuclear Science and Technology Group. The program is administered by the UNLV Graduate College. The Ph.D. program requires 60 credits of research and courses beyond the baccalaureate degree. Credit is required for four courses in nuclear chemistry, radiochemistry, detectors, and laboratory. The remaining courses are based on the area of interest of the student and include laboratory research. Students are obliged to maintain a B average and show progress in their research. The curriculum and research provides a comprehensive and interdisciplinary examination of topics and experiences necessary to produce graduates who are ready to secure employment and participate in radiochemistry research.

Learning Objectives

www.unlv.edu/degree/phd-radiochemistry

Plan Admission Requirements

Admission to the program is granted annually for the fall semester. Applicants should refer to both the radiochemistry and Graduate College websites for specific application deadlines.

Admission requirements include:

Completed Graduate College Application including applicable fees.

An earned undergraduate degree from a regionally accredited institution in the field of chemistry, radiochemistry, health physics, engineering or other related field with a minimum GPA of 3.0. Applicants with a GPA below 3.0, but not less than 2.75, may be admitted on a provisional basis.

Three letters of recommendation including one letter from an individual who can evaluate the applicant's ability to conduct graduate work at the PhD level. A second letter of recommendation must come from someone who has supervised the candidate in a work setting.

A current resume.

A statement of purpose explaining the applicant's career goals and why the doctorate would enhance the likelihood of achieving those goals. The statement should also explain why the applicant believes that he or she is qualified to conduct academic work at the advance graduate level. Finally, the statement should address the specific area of specialization the student would like to emphasize.

A score ranking in the 50th percentile or higher in the verbal and quantitative sections of the Graduate Record Exam (GRE).

Students meeting all of the above admission requirements may be asked to meet with the admission committee for a personal interview.

All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements.

Plan Requirements

Total Credits Required: 60

Course Requirements

- Core Courses – Credits: 12
  - RDCH 701 - Applied Nuclear Physics
  - RDCH 702 - Radiochemistry
  - HPS 602 - Radiation Detection
  - HPS 603 - Radiation Physics and Instrumentation Laboratory
- Electives – Credits: 30-36
  - Complete 30-36 credits of advisor-approved electives.
- Dissertation – Credits: 12-18
  - CHEM 799 - Dissertation

Degree Requirements

1. Students must complete a minimum of 60 credit hours with a minimum GPA of 3.00.

2. RDCH 702 must be completed before enrolling in RDCH 710.
3. Students enrolled in the Radiochemistry Ph.D. program are required to maintain satisfactory progress toward the degree as determined by the student's academic advisor and advisory committee. To maintain satisfactory progress in the Radiochemistry Ph.D. program, a student must:
    a. Maintain a cumulative grade point average of 3.0 or above each semester enrolled.
    b. Receive a grade of B (3.0) or above in all core Radiochemistry courses. If less than a B is earned in any given course, it may be repeated. The student must be in good standing to repeat a course, and courses may not be repeated more than one time.
    c. Schedule and take the oral qualifying exam within 1.5 years of satisfactorily completing the core Radiochemistry courses.
    d. Pass the dissertation prospectus defense within 3 years of entering the Radiochemistry Ph.D. program.
    e. Participate in Radiochemistry seminar. Students are required to participate in the weekly Radiochemistry seminar each semester they are in residence at UNLV. Students may only be exempted from this requirement due to scheduling conflicts, with the prior approval of their academic advisor.
4. Failure to make satisfactory progress as determined by the student's academic advisor and/or advisory committee may include: failure to complete six credits per calendar year toward the degree program; unsatisfactory grades (including Incompletes, grades below a B, or Withdrawals); failure to consult with the academic advisor when requested; failure to establish a graduate advisory committee; failure to establish the groundwork for an acceptable dissertation; failure of oral qualifying examination; failure to pass prospectus defense; or, continuous or willful neglect and/or intentional or continuous disregard for laboratory safety procedures.
5. To advance to candidacy, students are required to pass an oral exam on their research and an outside topic related to radiochemistry.
6. Complete all requirements for the Ph.D. degree within eight years, or six years if entering the program with a master's degree. If these requirements are not met, the program may place the student on academic probation or drop him/her from the Ph.D. program.
7. In consultation with his/her advisor, a student will organize a dissertation committee. The graduate advisory committee is responsible for guiding students through the Radiochemistry Ph.D. program. Upon entering the program, the Radiochemistry Graduate Coordinator will serve as academic advisor to all students until individual advisory committees have been established. The responsibility of establishing an advisory committee falls upon the students. By the end of the first year in the program, students must select an advisory committee chair who will also serve as the student's academic advisor from that point forward. By the end of the second year in the program, students must select the remaining members of the graduate advisory committee.
8. The graduate advisory committee consists of at least four graduate faculty members as follows:
    a. Advisory Committee Chair - must have full graduate faculty status in Radiochemistry.
    b. Graduate College Representative - must have full graduate faculty status at UNLV in a program outside of Radiochemistry and the host department. Faculty with status in Radiochemistry may not serve as the GC Rep.
    c. Committee Member - must have affiliate, associate or full graduate faculty status in Radiochemistry.
    d. Committee Member - must have affiliate, associate or full graduate faculty status in Radiochemistry.
9. The oral qualifying exam must be taken within 1.5 years of successfully completing the radiochemistry core courses listed above. The exam is designed to test students on the fundamental science underlying radiochemistry, including all content covered in the core courses. In addition, students are tested on their depth of knowledge in their area of research specialization.

10. The oral qualifying exam is held in closed session and is given by the qualifying examination committee. This committee is made up of a minimum of three members, the advisory committee chair, another member of the UNLV radiochemistry faculty, and an affiliate, associate or full graduate faculty status member in Radiochemistry. All members of the qualifying examination committee must be present during the oral qualifying exam. Additional members of the student's advisory committee may participate on the qualifying examination at the discretion of the academic advisor, but are not required to be present.
11. For the exam, students are responsible for preparing two presentations which are presented to the qualifying examination committee. The first presentation is an overview of the student's proposed research, including relevant literature, a proposed research plan and summary/results of current research. This presentation may serve as the basis for the Prospectus Defense as well. The second presentation summarizes a recent published scientific article on a topic not directly related to the candidate's proposed dissertation research. The article must be approved by the student's advisor prior to the exam.
12. Students who do not pass the exam may repeat the exam one time within 6 months, but no sooner than 3 months from the first attempt. Students who do not pass the oral qualifying exam on the second attempt will be severed from the program.
13. Students must schedule and take the oral qualifying exam within 1.5 years of satisfactorily completing the core Radiochemistry courses.
14. Students are required to participate in the weekly Radiochemistry seminar each semester they are in residence at UNLV. Students may only be exempted from this requirement due to scheduling conflicts, with the prior approval of their academic advisor.
15. Students must prepare and successfully defend their dissertation prospectus prior to the completion of their sixth semester. The prospectus will cover a review of the relevant literature, a statement of the problem or hypothesis to be examined and a research plan for the project. The prospectus will be defended to the student's advisory committee and will be open to the general research community. All members of the student's advisory committee must be present at the student's prospectus defense.
16. Students are expected to write a dissertation demonstrating both knowledge of a specific topic and the ability to conduct high quality original research. The dissertation must be accepted by the student's advisory committee prior to the completion of the degree program. Upon completion of the dissertation, the dissertation must be defended to the student's advisory committee in a public dissertation defense.
17. To advance to candidacy, students are required to pass the oral qualifying exam and successfully defend their dissertation prospectus. Upon successful completion of the prospectus defense, students shall be promoted to Ph.D. candidate the term following the defense.
18. The dissertation must be written in collaboration with the student's academic advisor and advisory committee. The dissertation must be accepted by the student's advisory committee prior to the completion of the degree program. Students must enroll in six credits of dissertation work each semester they are working on the dissertation and the minimum number of dissertation credits required for graduation is twelve.

Plan Graduation Requirements

The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.

The student must submit and successfully defend his/her dissertation by the posted deadline. The defense must be advertised and is open to the public.

The student must submit his/her approved, properly formatted hard-copy dissertation to the Graduate College, and submit the approved electronic version to ProQuest by the posted deadline.

Doctor of Philosophy - Chemistry

Plan Description

The Ph.D. degree in chemistry is primarily a research-based program that includes sufficient advanced course work to provide a strong background from which students may pursue forefront research, under the direct guidance of a faculty member, in their chosen areas of interest. The program is designed to develop the professional skills required to function as an independent researcher in chemistry.

Learning Outcomes

www.unlv.edu/degree/phd-chemistry

Plan Admission Requirements

For preferential consideration, please submit materials for Fall semester admission by February 1, and for Spring semester, by October 1.

The applicant is required to submit a completed Graduate College application, application fee and official transcripts to the Graduate College with copies submitted to the department.

Admission to the Ph.D. degree program in Chemistry requires a B.S. degree or a M.S. degree in Biochemistry, Chemistry, Biology, or a related discipline.

A minimum grade point average (GPA) of 3.00, on a 4.0 scale, for all undergraduate or graduate work is required for admission to the program.

In addition, the Graduate College application and official transcripts, the Department of Chemistry requires a statement of interest from the applicant. A letter of application should state interests and goals for graduate study. This is a 1-2 page essay describing the applicant's reasons for considering graduate study, goals after completion of the graduate degree, and the applicant's specific areas of interest.

The Department of Chemistry requires three letters of recommendation from persons familiar with the academic record of the applicant. Each letter should detail the potential of the applicant for advanced graduate work in Chemistry or Biochemistry.

The Department of Chemistry requires scores for GRE, General Record Exam, for admission.

All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements.

Plan Requirements

See Subplan Requirements below.

Subplan 1 Requirements: Post-Bachelor's Track

Total Credits Required: 60

Course Requirements

- Graduate Seminar Course – Credits: 5
  - CHEM 791 - Graduate Seminar
    - A minimum of 3 presentations are required.
- Coursework Elective Courses – Credits: 18-21
  - Complete 18-21 credits of advisor-approved coursework electives. These courses may include but are not limited to:

        - CHEM 790 - Directed Readings
        - CHEM 793 - Special Topics
- Research Elective Courses – Credits: 22-25
    - Complete 22-25 credits of advisor-approved research electives. These courses may include but are not limited to:
        - CHEM 792 - Research Seminar
        - CHEM 795 - Independent Study
        - CHEM 796 - Dissertation Prospectus
        - CHEM 797 - Directed Research
- Dissertation – Credits: 12
    - CHEM 799 - Dissertation

Degree Requirements

Doctoral students in Chemistry are required to complete a minimum of 60 credit hours beyond the baccalaureate. All 60 credits hours must be completed from courses at the 700-level.

All students are required to maintain a minimum a 3.00 grade point average in all graduate-level courses. Two grades of B- are permitted in the degree program as long as the GPA remains at or above 3.00. One grade of C+ or lower will result in academic probation even if the overall GPA is above 3.0. Two grades of C+ or lower will result in automatic suspension or separation from the program.

A dissertation advisor must be chosen by the end of the first semester, and the Doctoral Advisory Committee must be appointed prior to the end of the second semester. An approved graduate degree program must be filed prior to the beginning of the third semester of enrollment. All students must meet these deadlines; failure to do so will result in academic probation. Failure of a student on academic probation to meet these requirements within the next semester could result in separation from the program.

The Doctoral Advisory Committee must consist of the faculty advisor (chair), chemistry graduate faculty in the discipline of study, one additional chemistry graduate faculty member, and one graduate-college representative from outside the department. Failure to identify an advisor and form this committee will result in the student being placed on academic probation. The use of committee members external to UNLV is allowed with approval from the examination committee. External members without graduate faculty status at UNLV will be non-voting members of the Ph.D. examination committee.

All students are required to schedule an interview with the advisor either before or during the first semester of study. If the student does not select an advisor, the Graduate Coordinator will assign a temporary advisor. The purpose of the initial interview is to develop a plan of course work for the first year.

All students are required to schedule a diagnostic interview with the Doctoral Advisory Committee before the end of the 2nd semester. The purpose of the interview is to develop a list of recommended courses and design the student's degree program, which must be submitted prior to completing 16 credits of course work toward the degree.

All students must prepare a dissertation proposal for a Proposal Defense Examination. The student should register for the Dissertation Prospectus course. This examination must be completed prior to the end of the fourth semester. To remain in good standing students are required to develop and defend a dissertation prospectus no later than the fourth semester of enrollment. If a student does not defend a dissertation prospectus they will be placed on academic probation. The Proposal Defense Examination focuses on the dissertation proposal and the student's ability to perform the research. It includes a formal oral presentation of the student's dissertation proposal, research to date, and questions by the dissertation advisory committee on the dissertation topic. The Proposal Defense Examination is to be taken prior to the Comprehensive Examination.

Advancement to Candidacy. Students will advance to candidacy if the Comprehensive Examination is passed and the enrolled coursework is successfully completed based on the evaluation of the students Doctoral

Advisory Committee. The comprehensive exam will consist of written and oral components as defined by the Ph.D. Examination Committee. Satisfactory performance on the Comprehensive Examination requires that Ph.D. students have a basic knowledge of the discipline of study. It also requires the student to follow the guidelines established for each discipline (i.e., Biochemistry, Physical Chemistry, Analytical Chemistry, Inorganic Chemistry and Organic Chemistry). The student's Doctoral Advisory Committee or the faculty from the discipline of study will determine the format and content of both the written and oral exams.

The Ph.D. Examination Committee will determine if the student passes the Comprehensive Examination. If a student fails any part of the Comprehensive Examination, the Ph.D Examination Committee will determine if the student is allowed to retake the portion of the comprehensive exam that is not passed.

Students who fail to pass any part of the Comprehensive Examination or Proposal Defense on the first attempt must successfully complete a second attempt (as specified by the Ph.D. Examination Committee) within the next six months to remain in the program.

Failure to advance to candidacy by the end of the sixth semester of enrollment will result in the student being placed on academic probation. Failure to advance to candidacy by the end of the seventh semester will result in the student being separated from the program.

Students who enter the program with a baccalaureate degree and who fail the second examination may be allowed to continue as a Master of Science student with the consent of the Doctoral Advisory Committee.

A student who has successfully passed both the Proposal Defense and Comprehensive Examinations will advance to candidacy for the Ph.D. degree.

After advancement, subsequent years of study will be required for the graduate student to complete their degree. The duration of this period will depend on the success of the research project as defined by the Doctoral Advisory Committee.

Completed coursework will only be counted towards the graduation requirements of this program for eight years if the student completed a baccalaureate degree. It is recommended that students publish at least one research-based manuscript in a peer-reviewed journal prior to graduation.

Satisfactory performance on the final examination will consist of the presentation and defense of the dissertation research. The defense will consist of an oral presentation open to the public, a short period of questions from the public, a closed session of questions from the Doctoral Advisory Committee, and a closed deliberation and vote by just the Doctoral Advisory Committee members. Any graduate faculty member may attend the closed session of questions of the defense.

Graduation Requirements

See Plan Degree Requirements below.

Subplan 2 Requirements: Post-Master's Track

Total Credits Required: 30

Course Requirements

- Graduate Seminar Course – Credits: 5
  - CHEM 791 - Graduate Seminar
    - A minimum of 3 presentations are required.
- Elective Courses – Credits: 13

    - Complete 13 credits of advisor-approved electives. These courses may include but are not limited to:
        - CHEM 790 - Directed Readings
        - CHEM 792 - Research Seminar
        - CHEM 793 - Special Topics
        - CHEM 795 - Independent Study
        - CHEM 796 - Dissertation Prospectus
        - CHEM 797 - Directed Research
- Dissertation – Credits: 12
    - CHEM 799 - Dissertation

Degree Requirements

1. Doctoral students entering the Ph.D. program with an approved M.S. degree in Chemistry or a closely related discipline, are required to complete a minimum of 30 credit hours in the Ph.D. program at UNLV comprised of courses at the 700-level.
2. All students are required to maintain a minimum a 3.00 grade point average in all graduate-level courses. Two grades of B- are permitted in the degree program as long as the GPA remains at or above 3.00. One grade of C+ or lower will result in academic probation even if the overall GPA is above 3.0. Two grades of C+ or lower will result in automatic suspension or separation from the program.
3. A dissertation advisor must be chosen by the end of the first semester, and the Doctoral Advisory Committee must be appointed prior to the end of the second semester. An approved graduate degree program must be filed prior to the beginning of the third semester of enrollment. All students must meet these deadlines; failure to do so will result in academic probation. Failure of a student on academic probation to meet these requirements within the next semester could result in separation from the program.
4. The Doctoral Advisory Committee must consist of the faculty advisor (chair), chemistry graduate faculty in the discipline of study, one additional chemistry graduate faculty member, and one graduate-college representative from outside the department. Failure to identify an advisor and form this committee will result in the student being placed on academic probation. The use of committee members external to UNLV is allowed with approval from the examination committee. External members without graduate faculty status at UNLV will be non-voting members of the Ph.D. examination committee.
5. All students are required to schedule an interview with the advisor either before or during the first semester of study. If the student does not select an advisor, the Graduate Coordinator will assign a temporary advisor. The purpose of the initial interview is to develop a plan of course work for the first year.
6. All students are required to schedule a diagnostic interview with the Doctoral Advisory Committee before the end of the 2nd semester. The purpose of the interview is to develop a list of recommended courses and design the student's degree program, which must be submitted prior to completing 16 credits of course work toward the degree.
7. All students must prepare a dissertation proposal for a Proposal Defense Examination. The student should register for the Dissertation Prospectus course. This examination must be completed prior to the end of the fourth semester. To remain in good standing students are required to develop and defend a dissertation prospectus no later than the fourth semester of enrollment. If a student does not defend a dissertation prospectus they will be placed on academic probation. The Proposal Defense Examination focuses on the dissertation proposal and the student's ability to perform the research. It includes a formal oral presentation of the student's dissertation proposal, research to date, and questions by the dissertation advisory committee on the dissertation topic. The Proposal Defense Examination is to be taken prior to the Comprehensive Examination.
8. Advancement to Candidacy. Students will advance to candidacy if the Comprehensive Examination is passed and the enrolled coursework is successfully completed based on the evaluation of the students

Doctoral Advisory Committee. The comprehensive exam will consist of written and oral components as defined by the Ph.D. Examination Committee. Satisfactory performance on the Comprehensive Examination requires that Ph.D. students have a basic knowledge of the discipline of study. It also requires the student to follow the guidelines established for each discipline (i.e., Biochemistry, Physical Chemistry, Analytical Chemistry, Inorganic Chemistry and Organic Chemistry). The student's Doctoral Advisory Committee or the faculty from the discipline of study will determine the format and content of both the written and oral exams.

9. The Ph.D. Examination Committee will determine if the student passes the Comprehensive Examination. If a student fails any part of the Comprehensive Examination, the Ph.D Examination Committee will determine if the student is allowed to retake the portion of the comprehensive exam that is not passed.
    a. Students who fail to pass any part of the Comprehensive Examination or Proposal Defense on the first attempt must successfully complete a second attempt (as specified by the Ph.D. Examination Committee) within the next six months to remain in the program.
    b. Failure to advance to candidacy by the end of the sixth semester of enrollment will result in the student being placed on academic probation. Failure to advance to candidacy by the end of the seventh semester will result in the student being separated from the program.
    c. Students who entered the program with a master's degree who fail the examination a second time will be separated from the program.
    d. A student who has successfully passed both the Proposal Defense and Comprehensive Examinations will advance to candidacy for the Ph.D. degree.
    e. After advancement, subsequent years of study will be required for the graduate student to complete their degree. The duration of this period will depend on the success of the research project as defined by the Doctoral Advisory Committee.
    f. Completed coursework will only be counted towards the graduation requirements of this program for six years. It is recommended that students publish at least one research-based manuscript in a peer-reviewed journal prior to graduation.
    g. Satisfactory performance on the final examination will consist of the presentation and defense of the dissertation research. The defense will consist of an oral presentation open to the public, a short period of questions from the public, a closed session of questions from the Doctoral Advisory Committee, and a closed deliberation and vote by just the Doctoral Advisory Committee members. Any graduate faculty member may attend the closed session of questions of the defense.

Graduation Requirements

See Plan Graduation Requirements below.

Plan Graduation Requirements

The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.

The student must submit and successfully defend his/her dissertation by the posted deadline. The defense must be advertised and is open to the public. The student must submit his/her approved, properly formatted hard-copy document to the Graduate College, and submit the approved electronic version to ProQuest by the posted deadline.

Chemistry Courses

CHEM 602 - Scientific Software for the Microcomputer
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

CHEM 621 - Physical Chemistry
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

CHEM 622 - Physical Chemistry II
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

CHEM 628 - Quantum Chemistry
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

CHEM 631 - Advanced Inorganic Chemistry
Credits 3
Atomic and nuclear properties. Structure, symmetry, and bonding for molecular and solid-state compounds. Solution behavior, solubility, acid-based properties. Chemistry of the elements and periodic trends. **Prerequisites** CHEM 422 or equivalent.

CHEM 655 - Instrumental Analysis
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

CHEM 672 - Biochemistry Laboratory
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work. This course offered by another department may also be taken for graduate credit.

CHEM 676 - Advanced Topics in Biochemistry
Credits 3
In depth study of selected advanced topics in biochemistry, cancer biochemistry or other medically-related topics in biochemistry. **Notes** May be repeated (different topic) once for a total of 6 credits to be applied toward graduate degree program. **Prerequisites** CHEM 475, graduate standing or permission of instructor.

CHEM 678 - Endocrinology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

CHEM 710 - Environmental Aquatic Chemistry
Credits 3
Study of the chemistry of natural waters, emphasizing chemical speciation and the interaction of aqueous media with soil and air. Considerable attention given to the use and limitations of thermodynamic equilibrium models of chemical speciation. **Prerequisites** Graduate standing or consent of instructor.

CHEM 715 - Environmental Organic Chemistry
Credits 3
Organic chemistry of natural waters, soils and the atmosphere, emphasizing chemical reactions, sorption, bio-

concentration and fate and transport. Use and limitation of thermodynamic and kinetic models and the extrapolation of laboratory data to environmental conditions. **Prerequisites** Graduate standing in chemistry or consent of instructor.

CHEM 725 - Advanced Organic Chemistry
Credits 3
Advanced study of structures and reactions of organic compounds. Reactive intermediates, reaction mechanism, stereochemistry, and synthesis examined. **Prerequisites** CHEM 242 and 421.

CHEM 726 - Organic Synthesis
Credits 3
Study of the synthesis of complex organic molecules. Stereochemistry, use of organometallic reagents and chiral auxiliaries stressed, with considerable emphasis on current literature. **Prerequisites** CHEM 242, 421

CHEM 728 - Organic Synthesis Laboratory
Credits 2
Some reasonably challenging syntheses undertaken to include reactions requiring rigid exclusion of air and moisture. Products characterized by modern spectroscopic methods. **Notes** Eight hours laboratory per week. **Prerequisites** CHEM 242, 421, 447 or consent of instructor.

CHEM 735 - Advanced Physical Chemistry
Credits 3
Statistical and quantum mechanics and their use in calculating thermodynamic properties. **Prerequisites** CHEM 421 and 428

CHEM 745 - Instrumental Analysis-Inorganic
Credits 3
Theory of modern analytical instrumentation as it pertains to inorganic analysis. **Notes** May include atomic emission and absorption, x-ray, radioactivity and mass spectroscopic methods.

CHEM 746 - Instrumental Analysis-Organic
Credits 3
Theory of modern analytical instrumentation as it pertains to organic analysis. May include gas chromatography-mass spectrometry, supercritical fluid chromatography, nuclear magnetic resonance, Fourier transform infrared methods and fluorescence techniques.

CHEM 749 - Polymer Chemistry
Credits 3
Polymer structure; classification of polymerization reactions, step-growth and chain-growth polymerization reactions; condensation, radical, cationic, and anionic polymerization reactions; physical properties and characterization of polymers. **Prerequisites** Consent of instructor.

CHEM 750 - Quality Assurance and Statistics
Credits 3
Purpose, theory, and applications of quality assurance/quality control. Experimental design including development of sampling protocols. Statistics relating to the evaluation of data quality covered. **Notes** Not a theoretical statistics course. **Prerequisites** STA 161 and CHEM 455.

CHEM 752 - Chromatography
Credits 3
Theory and applications of chromatography as the basis of analytical separations for inorganic and organic analyses. Separating power, selectivity, efficiency, and limitations of the various methods discussed. **Prerequisites** CHEM 241, 422, and 455.

CHEM 755 - Sample Preparation and Analysis
Credits 3

Collection, preparation, and analysis of gaseous, soil, and water samples using approved standard methods. Techniques used may include gas chromatography, gas chromatographymass spectroscopy, high performance liquid chromatography- atomic absorption spectroscopy, and inductively coupled plasma atomic emission spectroscopy. **Notes** One hour lecture and six hours laboratory. Consult instructor(s) prior to enrollment. **Prerequisites** Graduate standing in chemistry.

CHEM 760 - Environmental Radiochemistry/Radiation Safety
Credits 3
Practical applications of radiochemistry to topics of current and future concern, such as the temporary and permanent storage of radioactive wastes, nuclear utilities, nuclear medicine and isotope geology. Includes advanced radiochemical techniques and radiation safety training. **Prerequisites** CHEM 421 and 422 or equivalent, or consent of instructor.

CHEM 765 - Inorganic Chemistry
Credits 3
Physical approach to inorganic compounds, mainly of the transition elements including bonding, stereochemistry, and electronic properties with use of symmetry and elementary group theory. **Prerequisites** CHEM 422

CHEM 770 - Protein Chemistry
Credits 3
Protein structure and function. Enzymology (kinetics, regulation). Survey of techniques used in protein purification and analysis. **Prerequisites** CHEM 475 or equivalent.

CHEM 771 - Metabolism and Energetics
Credits 3
Biochemical pathways of carbohydrate, lipid, nucleic acid and amino acid metabolism and the mechanism of mitochondrial ATP synthesis. **Prerequisites** CHEM 475

CHEM 772 - Nucleic Acid Chemistry
Credits 3
Chemistry and function of nucleic acids (DNA, RNA) and their analogs. **Prerequisites** CHEM 475 or equivalent.

CHEM 773 - Physical Biochemistry
Credits 3
Theory and practice of physical chemistry as applied to the structure, properties, and interactions of biochemical macromolecules. Includes thermodynamics, various types of spectroscopy, electrophoresis, ligand binding, and hydrodynamic methods (covering the theoretical aspects of diffusion, sedimentation, and viscosity). **Prerequisites** CHEM 475

CHEM 775 - Bioanalytical Environmental Toxicology
Credits 3
Principles of toxicology. Study of the interaction of toxicants with biochemical pathways. Emphasis on toxic chemicals of environmental interest. **Prerequisites** CHEM 475

CHEM 783 - Spectral Interpretation
Credits 3
Spectroscopic data obtained from the techniques of nuclear magnetic resonance (NMR), mass spectrometry (MS), infrared (IR) and ultraviolet-visble (UV-VIS) spectrophotometry used to establish structural features of organic molecules. Emphasizes strategies, interpretation, modern techniques, and problem solving. **Prerequisites** Consent of instructor.

CHEM 784 - Spectral Interpretation Laboratory
Credits 1
Identification and characterization of an organic compound using infrared, ultraviolet, mass, and NMR spectrometers. Proton, carbon-13, and two-dimensional NMR spectra used to fully determine the structure. **Corequisite** CHEM 783

CHEM 790 - Directed Readings
Credits 1
Directed readings in the primary literature supportive of the dissertation prospectus. **Notes** May be repeated, but only three credits are applied to the academic program. **Prerequisites** Enrollment in the Chemistry or Radiochemistry doctoral program.

CHEM 791 - Graduate Seminar
Credits 1
Attendance and participation in seminar presentations. Includes student presentations. For master's students, enrollment is required. Two presentations are required. **Notes** May be repeated for a maximum of five credits. **Grading** S/F. **Prerequisites** Graduate standing in Chemistry or Radiochemistry.

CHEM 792 - Research Seminar
Credits 3
Public defense of a graduate research project in the Ph.D. Program. **Prerequisites** Graduate standing in Chemistry or Radiochemistry.

CHEM 793 - Special Topics
Credits 3
Study of a topic of interest from any field of chemistry (for example, analytical chemistry, biochemistry, etc.), at an advanced level. Topic varies each semester. Topic chosen will be published in the class schedule. **Notes** May be repeated for credit if classes are in different topics. **Prerequisites** Graduate standing in chemistry.

CHEM 795 - Independent Study
Credits 1–3
Individual directed study of a topic not covered in other courses. **Notes** May be repeated once for credit. May be repeated to a maximum of six credits. **Prerequisites** Graduate standing in chemistry and consent of instructor.

CHEM 796 - Dissertation Prospectus
Credits 1
Development of a prospectus and its defense before the Ph.D. examination committee. **Prerequisites** Enrollment in the Chemistry or Radiochemistry doctoral program.

CHEM 797 - Directed Research
Credits 1–6
Supervised research in the doctoral program. May be repeated for a maximum of twelve credits. **Prerequisites** Enrollment in the Chemistry or Radiochemistry doctoral program.

CHEM 798 - Thesis
Credits 3–6. **Notes** May be repeated, but only nine credits applied to the student's program. **Grading** S/F grading only. **Prerequisites** CHEM 745 or CHEM 746 and consent of instructor.

CHEM 799 - Dissertation
Credits 3–6
Research, analysis, and writing toward completion of dissertation and subsequent defense. **Notes** May be repeated but a minimum of eighteen credits and a maximum of twenty four credits will be applied toward fulfillment of degree requirements. **Grading** S/F grading only. **Prerequisites** Graduate standing in Chemistry or Radiochemistry and consent of instructor.

RDCH 701 - Applied Nuclear Physics
Credits 3
Introduces nuclear properties in radiation and radiochemistry. Concepts of the nuclei, radioactive decay, and nuclear reactions examined. Use of quantum mechanics in development of nuclear models and equations. Physics involved in interaction of radiation with matter. **Prerequisites** General physics, graduate standing in Radiochemistry program.

RDCH 702 - Radiochemistry
Credits 3
Introduces chemical properties in radiation and radiochemistry. Use of stability constants and relationship between speciation, kinetics and thermodynamics. Influence of radiolysis on chemistry of radioisotopes. Radioisotope production and use. Radiochemical separations. **Prerequisites** Inorganic chemistry, physical chemistry, graduate standing in Radiochemistry program.

RDCH 710 - Actinide Chemistry
Credits 3
Basis for unique chemistry of actinide elements described and related to oxidation-reduction, complexation, forbital interaction, and spectroscopy. Using nuclear properties in understanding actinide chemistry covered. Presentations on exploiting chemical behavior of actinides in separation, nuclear fuel cycle, environmental behavior, and materials. **Prerequisites** RDCH 702, graduate standing in Radiochemistry program.

RDCH 750 - Radiochemistry Laboratory Research
Credits 3
Experimental laboratory research conducted by the student under supervision. The student supplies research topic and provides suitable literature and background information. Research plan developed in conjunction with instructor. The student obtains experience in performing radiochemical laboratory research. **Prerequisites** Undergraduate chemistry laboratory experience, graduate standing in the Radiochemistry program.

Geoscience

The Department of Geoscience is an active and enthusiastic department consisting of eighteen full-time faculty, approximately sixty graduate students and one hundred undergraduate majors. The department offers a program of courses, seminars and research opportunities leading to Master of Science and Doctor of Philosophy degrees in Geoscience. The interests of the faculty and students cover a wide range of topics. Graduate students can choose one of three Geoscience emphases: Geology, Hydrogeology, and Soil Science. Active research by faculty and students is ongoing throughout the western United States, as well as in Antarctica, Canada, Chile, China, Costa Rica, Indonesia, France, Guatemala, Mexico, New Zealand, Panama, Poland, Russia, South Africa, Spain, and Switzerland.

The department encourages interdisciplinary research. Opportunities for geological and interdisciplinary research may be pursued with organizations near, or on, campus that cooperate with the department including: the Harry Reid Center (HRC) for Environmental Studies; the Division of Hydrologic Sciences of the Desert Research Institute (DRI), a division of the University and Community College System of Nevada; the Environmental Monitoring and Support Laboratory of the Environmental Protection Agency (EPA); the Department of Energy; and other university departments and schools such as life sciences, chemistry, physics, and engineering.

Students are encouraged to read the general graduate college rules and regulations elsewhere in this catalog and to read the Department of Geoscience Graduate Student Guidelines, which are available on the department's web site at: http://geoscience.unlv.edu/graduateprogram.htm. An understanding of these documents is essential for satisfactory progress toward the degree.

Terry Spell, Ph.D., Chair
Matthew Lachniet, Ph.D., Graduate Coordinator

Chair

Spell, Terry- *Full Graduate Faculty*
Associate Professor; B.S., West Georgia College; M.S., New Mexico Institute of Mining and Technology; Ph.D., State University of New York, Albany. *Rebel since 1996.*

Graduate Coordinator

Lachniet, Matthew - *Full Graduate Faculty*
Associate Professor; B.A., Antioch College; M.S., Michigan State University, Ph.D., Syracuse University. *Rebel since 2003.*

Graduate Faculty

Buck, Brenda- *Full Graduate Faculty*
Associate Professor; B.S., University of Notre Dame; M.S., Ph.D., New Mexico State University. *Rebel since 1998.*

Burnley, Pamela- *Full Graduate Faculty*
Associate Research Professor; B.S., Brown University; M.S., Ph.D., University of California Davis. *Rebel since 2008.*

Cline, Jean S. - *Full Graduate Faculty*
Professor; B.S., Wisconsin State University; M.S., University of Arizona; Ph.D., Virginia Polytechnic Institute and State University. *Rebel since 1990.*

Hanson, Andrew - *Full Graduate Faculty*
Associate Professor; B.S., Montana State University; M.S., San Diego State University; Ph.D., Stanford University. *Rebel since 2000.*

Hausrath, Elisabeth - *Full Graduate Faculty*
Assistant Professor; B.S., Brown University; Ph.D., Pennsylvania State University. *Rebel since 2009.*

Jiang, Ganqing Q. - *Full Graduate Faculty*
Associate Professor; B.A., Xiangtan Mining College; M.Sc., China University of Geosciences; Ph.D., Columbia University. *Rebel since 2004.*

Kreamer, David K. - *Full Graduate Faculty*
Professor; B.S., M.S., Ph.D., University of Arizona. *Rebel since 1990.*

Metcalf, Rodney V. - *Full Graduate Faculty*
Associate Professor; B.S., M.S., University of Kentucky; Ph.D., University of New Mexico. *Rebel since 1991.*

Nicholl, Michael J.- *Full Graduate Faculty*
Associate Professor; B.S., Eastern Michigan University; M.S., Ph.D., University of Nevada, Reno. *Rebel since 2004.*

Nowicki, Scott- *Associate Graduate Faculty*
Assistant Professor in Residence; B.S., Augustana College; M.S., Ph.D., Arizona State University. *Rebel since 2008.*

Ren, Minghua - *Associate Graduate Faculty*
Assistant Research Professor; B.S., Nanjing University; M.S., Ph.D. Baylor University. *Rebel since 2011.*

Rowland, Stephen M. - *Full Graduate Faculty*
Professor; A.B., University of California, Berkeley; Ph.D., University of California, Santa Cruz. *Rebel since 1978.*

Smith, Eugene I. - *Full Graduate Faculty*
Professor; B.S., Wayne State University; M.S., Ph.D., University of New Mexico. *Rebel since 1980.*

Taylor, Wanda J. - *Full Graduate Faculty*
Professor; B.S., University of Minnesota; M.S., Syracuse University; Ph.D., University of Utah. *Rebel since 1991.*

Tschauner, Oliver- *Associate Graduate Faculty*
Associate Research Professor; B.S., M.S., Ph.D. (Dr. rer. nat.), University of Cologne. *Rebel since 2008.*

Wells, Michael L.- *Full Graduate Faculty*
Professor; B.S., University of California, Santa Cruz; M.S., Ph.D., Cornell University. *Rebel since 1993.*

Yu, Zhongbo - *Full Graduate Faculty*
Professor; B.S., Hohai University; M.S., University of Southern Mississippi; Ph.D., Ohio State University. *Rebel since 1999.*

Professors Emeriti

Bachhuber, Frederick W.
Emeritus Professor; B.S., M.S., University of Wisconsin; Ph.D., University of New Mexico. *UNLV Emeritus 1974-2002.*

Geoscience Plans

Master of Science - Geoscience

Plan Description

The Master of Science – Geoscience degree is designed to prepare students for a broad range of challenging careers in government service, private consulting, and industry. This thesis-based degree program also serves as a stepping-stone for those students who wish to pursue further graduate studies at the Doctoral level. Working closely with their advisor, students focus on original research in one of several areas of specialization, including: petrology, volcanology, economic geology, structural geology, sedimentology, geochemistry, hydrology, soil science, climate change, petroleum geology, and paleontology. Students are expected to develop original research suitable for submission to a refereed scientific journal. Students are expected to have strong content knowledge in their area of emphasis, which is tested during the culminating defense of their thesis research.

Learning Outcomes

www.unlv.edu/degree/ms-geoscience

Plan Admission Requirements

All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements.

Geology Track

The emphasis in Geology includes the fields of economic geology, environmental geology, geochemistry, geochronology, geomorphology, igneous petrology, paleontology, metamorphic petrology, Quaternary geology, pedology, sedimentology, stratigraphy, structural geology, surficial processes, tectonics, and volcanology. Applicants must satisfy the following requirements:

- A bachelor's degree in geology or equivalent.
- In order to be admitted without contingencies the student must have completed an introductory geology class and six of the following eight classes (or their equivalents): mineralogy, geochemistry, geomorphology, structural geology, igneous and metamorphic petrology, paleontology, field geology, and sedimentology/stratigraphy.

Geophysics Track

Applicants must satisfy the following requirements:

- A bachelor's degree in geology, engineering, physics or mathematics.
- To be admitted to the program with a Geophysics emphasis, it is recommended that the student have completed the following courses for unconditional admission to the program.
    - Mathematics: Three semesters of calculus
    - Physics: Two semesters of introductory (calculus level) physics
    - Geology: Physical geology, historical geology, mineralogy, structural geology, sedimentology/stratigraphy, and igneous and metamorphic petrology.

Soil Science Track

Applicants must satisfy the following requirements:

- B.S. degree in a Natural Science (or similar field and course work) or B.A. degree in Natural Science (or similar field and course work) with approval of the graduate coordinator.

- To be admitted to the program with a Soil Science emphasis, it is recommended that the student have completed two of the following courses for unconditional admission to the program: Mineralogy, Geomorphology, Sedimentology/Stratigraphy, or Geochemistry.

Hydrogeology Track

Applicants must satisfy the following requirements:

- A B.S. degree in geology or a related discipline (e.g., civil engineering).
- To be admitted to the program with a hydrogeology emphasis, it is required that the student have completed four of the following courses (or their equivalents) for unconditional admission to the program:
    - GEOL 474 – Hydrogeology
    - GEOL 330 – Geochemistry
    - GEOL 333 – Geomorphology
    - GEOL 341 – Structural Geology
    - GEOL 348 – Field Geology
    - GEOL 462 – Stratigraphy and Sedimentology

Plan Requirements

See Subplan Requirements below.

Subplan 1 Requirements: Geology Track

Total Credits Required: 30

Course Requirements

- Required Courses – Credits: 4
    - GEOL 701 - Research Methods in Geoscience
    - GEOL 795 - Poster Presentation and Time Management
- Elective Courses – Credits: 20
    - Complete 20 credits of 600- or 700-level GEOL courses, or other advisor-approved courses.
- Thesis – Credits: 6
    - GEOL 797 - Thesis

Degree Requirements

See Plan Degree Requirements below.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 2 Requirements: Geophysics Track

Total Credits Required: 30

Course Requirements

- Required Courses – Credits: 4
    - GEOL 701 - Research Methods in Geoscience
    - GEOL 795 - Poster Presentation and Time Management
- Core Course – Credits: 3
    - Complete one of the following courses:
        - CEE 636 - Engineering Geophysics
        - GEOL 645 - Geophysical Methods
- Additional Core Course – Credits: 3
    - Complete one of the following courses:
    - ECG 780 - Digital Signal Processing
    - GEOL 793 - Independent Study and Research
- Geophysics Courses – Credits: 9
    - Complete 9 credits in three or more of the following courses, or other advisor-approved courses.
        - BIOL 618 - Microbial Ecology
        - CEE 634 - Rock Mechanics
        - CEE 636 - Engineering Geophysics
        - CEE 676 - Earthquake Engineering
        - CEE 737 - Soil Dynamics and Earthquake Engineering
        - CEE 775 - Seismic Response of Structures
        - GEOL 630 - Geographic Information Systems (GIS): Theory and Applications
        - GEOL 643 - Plate Tectonics
        - GEOL 644 - Tectonics of Orogenic Belts
        - GEOL 646 - Geologic Applications in Remote Sensing
        - GEOL 678 - Hydrogeochemistry
        - GEOL 688 - Microtechniques in Geoscience
        - GEOL 716 - Geostatistics
        - GEOL 744 - Tectonics and Structures
        - GEOL 745 - Advanced Structural Geology
        - GEOL 746 - Strain and Microstructural Analysis
        - GEOL 747 - Geological Evolution of Western North America
        - GEOL 770 - Sedimentary Basins
        - GEOL 772 - Reflection Seismic Data Interpretation
        - GEOL 773 - Seminar in Geophysics
- Elective Courses – Credits: 5
    - Complete 5 credits from the following list of courses, or other advisor-approved courses that are appropriate for the course of study.
        - BIOL 618 - Microbial Ecology
        - CEE 634 - Rock Mechanics
        - CEE 636 - Engineering Geophysics
        - CEE 676 - Earthquake Engineering
        - CEE 737 - Soil Dynamics and Earthquake Engineering
        - CEE 775 - Seismic Response of Structures
        - GEOL 630 - Geographic Information Systems (GIS): Theory and Applications
        - GEOL 643 - Plate Tectonics
        - GEOL 644 - Tectonics of Orogenic Belts
        - GEOL 646 - Geologic Applications in Remote Sensing
        - GEOL 678 - Hydrogeochemistry
        - GEOL 688 - Microtechniques in Geoscience

        - GEOL 716 - Geostatistics
        - GEOL 744 - Tectonics and Structures
        - GEOL 745 - Advanced Structural Geology
        - GEOL 746 - Strain and Microstructural Analysis
        - GEOL 747 - Geological Evolution of Western North America
        - GEOL 770 - Sedimentary Basins
        - GEOL 772 - Reflection Seismic Data Interpretation
        - GEOL 773 - Seminar in Geophysics
- Thesis – Credits: 6
    - GEOL 797 - Thesis

Degree Requirements

See Plan Degree Requirements below.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 3 Requirements: Soil Science Track

Total Credits Required: 30

Course Requirements

- Required Courses – Credits: 10
    - GEOL 610 - Soil Classification and Resource Management
    - GEOL 701 - Research Methods in Geoscience
    - GEOL 786 - Soils Applications: Paleoclimate, Neotectonics, Archeology
    - GEOL 795 - Poster Presentation and Time Management
- Elective Courses – Credits: 14
    - Complete 14 credits from the following list of courses, or other advisor-approved courses that are appropriate for the course of study.
        - BIOL 618 - Microbial Ecology
        - BIOL 745 - Arid Zone Soils
        - GEOL 630 - Geographic Information Systems (GIS): Theory and Applications
        - GEOL 646 - Geologic Applications in Remote Sensing
        - GEOL 688 - Microtechniques in Geoscience
        - GEOL 712 - Watershed Hydrology
        - GEOL 716 - Geostatistics
        - GEOL 719 - Vadose Zone Hydrology
        - GEOL 735 - Seminar in Environmental Geology
        - GEOL 740 - Arid Zone Soils
        - GEOL 744 - Tectonics and Structures
        - GEOL 760 - Advanced Spatial Modeling with GIS
        - GEOL 770 - Sedimentary Basins
        - GEOL 776 - Paleosols Records of Past Landscapes
- Thesis – Credits: 6
    - GEOL 797 - Thesis

Degree Requirements

See Plan Degree Requirements below.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 4 Requirements: Hydrogeology Track

Total Credits Required: 30

Course Requirements

- Required Courses – Credits: 4
  - GEOL 701 - Research Methods in Geoscience
  - GEOL 795 - Poster Presentation and Time Management
- Elective Courses – Credits: 20
  - Complete 20 credits from the following list of courses, or other advisor-approved courses that are appropriate for the course of study.
    - GEOL 630 - Geographic Information Systems (GIS): Theory and Applications
    - GEOL 646 - Geologic Applications in Remote Sensing
    - GEOL 674 - Hydrogeology
    - GEOL 678 - Hydrogeochemistry
    - GEOL 709 - Field Methods in Hydrogeology
    - GEOL 711 - Principles of Hydrology and Hydraulics
    - GEOL 712 - Watershed Hydrology
    - GEOL 715 - Advanced Hydrogeology
    - GEOL 716 - Geostatistics
    - GEOL 719 - Vadose Zone Hydrology
    - GEOL 740 - Arid Zone Soils
    - GEOL 744 - Tectonics and Structures
    - GEOL 760 - Advanced Spatial Modeling with GIS
    - GEOL 765 - Seminar in Stratigraphy
    - GEOL 785 - Seminar in Sedimentology
    - GEOL 792 - Seminar in Hydroscience
- Thesis – Credits: 6
  - GEOL 797 - Thesis

Degree Requirements

See Plan Degree Requirements below.

Graduation Requirements

See Plan Graduation Requirements below.

Plan Degree Requirements

- Students must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
- At least 12 credits (excluding thesis) must be in 700-level courses.
- GEOL 701 and GEOL 795 must be taken during the first year of enrollment.
- Credits taken at other institutions will be considered for transfer; however, at least 16 of the 24 course credits required for the degree (not including thesis credits) must be taken at UNLV.
- Students must confer with their appointed advisor prior to enrollment in their first semester. Using Degree Audit as a guide, a degree program must be approved by the advisory committee. A thesis prospectus must be filed with the Graduate College, and a thesis committee must be appointed by the end of the second semester after admission to the college. This responsibility rests with the student. Students will be dropped from the program and separated from the Graduate College if they fail to fulfill this requirement.
- In consultation with his/her advisor, a student will organize a thesis committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.
- Satisfactory progress toward meeting the degree requirements is required of all students. Satisfactory progress includes maintaining at least a 3.00 grade point average in all graduate-level courses. Consult the Geoscience Graduate Student Guidelines at http://geoscience.unlv.edu/graduatestudentguidelines.htm for full details.

Plan Graduation Requirements

- The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
- The student must submit and successfully defend his/her thesis by the posted deadline. The defense must be advertised and is open to the public.
- The student must submit his/her approved, properly formatted hard-copy thesis to the Graduate College, and submit the approved electronic version to ProQuest by the posted deadline.

Doctor of Philosophy - Geoscience

Plan Description

The Doctor of Philosophy – Geoscience degree is designed to prepare students for demanding research-oriented careers in academia, government service, private consulting, and industry. Working closely with their advisors, students focus on original research in an emphasis area. Research expectations are high; students are expected to develop original lines of research that will lead to three or more original manuscripts that are suitable for submission to a refereed scientific journal. Students are expected to have strong content knowledge in their area of emphasis and three additional sub-disciplines of the geologic sciences. Fundamental knowledge levels are tested first in a diagnostic interview that is used to guide coursework taken by the student, and then later in a comprehensive exam.

Learning Outcomes

www.unlv.edu/degree/phd-geoscience

Plan Admission Requirements

All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements.

Geology Track

The emphasis in Geology includes the fields of economic geology, environmental geology, geochemistry, geochronology, geomorphology, igneous petrology, paleontology, metamorphic petrology, Quaternary geology, pedology, sedimentology, stratigraphy, structural geology, surficial processes, tectonics, and volcanology. Applicants must satisfy the following requirements:

- For the Post-Bachelor's Track: A bachelor's degree in geology or equivalent.
- For the Post-Master's Track: A Master of Science degree in geology or equivalent.
- It is recommended that the student have completed the following courses for unconditional admission to the program. An introductory geology class and six of the following eight classes (or their equivalents): mineralogy, geochemistry, geomorphology, structural geology, igneous and metamorphic petrology, paleontology, field geology, and sedimentology/stratigraphy.

Geophysics Track

Applicants must satisfy the following requirements:

- For the Post-Bachelor's Track: A bachelor's degree in geology, engineering, physics or mathematics.
- For the Post-Master's Track: A Master of Science degree.
- To be admitted to the program with a Geophysics emphasis, it is recommended that the student have completed the following courses for unconditional admission to the program.
    - Mathematics: Three semesters of calculus
    - Physics: Two semesters of introductory (calculus level) physics
    - Geology: Physical geology, historical geology, mineralogy, structural geology, sedimentology/stratigraphy, and igneous and metamorphic petrology.

Soil Science Track

Applicants must satisfy the following requirements:

- For the Post-Bachelor's Track: B.S. degree in a Natural Science (or similar field and course work) or B.A. degree in Natural Science (or similar field and course work) with approval of the graduate coordinator.
- For the Post-Master's Track: A Master of Science degree.
- To be admitted to the program with a Soil Science emphasis, it is recommended that the student have completed two of the following courses for unconditional admission to the program: Mineralogy, Geomorphology, Sedimentology/Stratigraphy, or Geochemistry.

Hydrogeology Track

Applicants must satisfy the following requirements:

- For the Post-Bachelor's Track: A B.S. degree in geology or a related discipline (e.g., civil engineering).
- For the Post-Master's Track: A master's degree in geology or a related discipline (e.g., civil engineering).

- To be admitted to the program with a hydrogeology emphasis, it is required that the student have completed four of the following courses (or their equivalents) for unconditional admission to the program:

    - GEOL 474 - Hydrogeology
    - GEOL 330 - Geochemistry
    - GEOL 333 - Geomorphology
    - GEOL 341 - Structural Geology
    - GEOL 348 - Field Geology
    - GEOL 462 - Stratigraphy and Sedimentology

Plan Requirements

See Subplan Requirements below.

Subplan 1 Requirements: Post-Bachelor's - Geology Track

Total Credits Required: 60

Course Requirements

- Required Course – Credits: 3
    - GEOL 701 - Research Methods in Geoscience
- Elective Courses – Credits: 45
    - Complete 45 credits of 600- or 700-level GEOL courses, or other advisor-approved courses.
- Dissertation – Credits: 12
    - GEOL 799 - Dissertation

Degree Requirements

- Students must complete a minimum of 60 credit hours with a minimum GPA of 3.00.
- A minimum of 24 of the 60 credits required must be at the 700-level.
- Although more course work and dissertation credits may be taken, only 12 credits of Dissertation, and 48 course credits will be counted toward the degree program.
- Doctoral students are encouraged to take courses from outside of geoscience; however, a minimum of 15 credits must be geoscience (GEOL) courses.
- A maximum of three credits of Independent Study are permitted, except in special circumstances in which case permission from the doctoral advising committee, the department Graduate Coordinator and the department chair is required.
- Satisfactory progress toward meeting the degree requirements is required of all candidates. Satisfactory progress is defined as, at a minimum:
    - Maintenance of at least a 3.00 grade point average in all graduate-level courses. Two grades of B- are permitted in the degree program as long as the GPA remains at or above 3.00. One grade of C+ or lower results in academic probation even if the overall GPA is above 3.0. Two grades of C+ or lower will result in automatic suspension from the program.
    - Selecting a dissertation advisor and committee. The advisor must be selected before the end of the first semester and the committee before the end of the second semester.

- Scheduling of an interview with the advisor either during or before the first semester. If an advisor is not selected, a temporary advisor will be assigned by the graduate coordinator. The purpose of the interview is to develop a plan of course work for the first year.
- In consultation with his/her advisor, a student will organize a thesis committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.
- Scheduling of a diagnostic interview with the Advisory Committee before the end of the 2nd semester. The purpose of the interview is to develop a list of recommended courses and design the student's degree program, which must be submitted prior to completing 16 credits of course work toward the degree.
- Preparation of a dissertation proposal and satisfactory performance on a Proposal Defense Examination. This examination must be completed prior to the end of the third semester. The Proposal Defense Examination focuses on the dissertation proposal and the student's ability to perform the research. It includes a formal oral presentation of the student's dissertation proposal, research to date, and questions by the dissertation advisory committee on the dissertation topic. The Proposal Defense Examination is to be taken prior to the Comprehensive Examination.
- Satisfactory performance on the Comprehensive Examination. Ph.D. students must have a basic knowledge of Physical Geology in addition to a comprehensive knowledge of three fields of geosciences (see Department of Geoscience Graduate Student Guidelines for recommended fields for each Ph.D. Emphasis). The format and content of the exam will be determined by the student's doctoral advisory committee with approval of the department graduate coordinator. The Comprehensive Examination will be taken either the semester after all course work is completed or before the end of the fifth semester, whichever comes first. The examination will be oral. In exceptional circumstances, as determined by the student's dissertation committee and the graduate coordinator, the examination will consist of both oral and written components. Students who fail to pass the Comprehensive Examination or Proposal Defense on the first attempt must successfully complete a second examination (as specified by the doctoral advisory committee) within the next six months to remain in the program. Students who entered the program with a baccalaureate degree and who fail the second examination may be allowed to continue as a Master of Science student with the consent of the doctoral advising committee. Students who entered the program with a master's degree who fail the examination a second time will be separated from the program. A student who has successfully passed both the Proposal Defense and Comprehensive Examinations will be admitted to candidacy for the Ph.D. degree.
- Satisfactory performance on a final examination will consist of the presentation and defense of the dissertation research. The defense will consist of an oral presentation open to the public, a short period of questions from the public, a closed session of questions from the doctoral advising committee, and a closed deliberation and vote by just the advisory committee members. Any graduate faculty member may attend the closed session of questions of the defense.

- Using Degree Audit as a guide, a degree program must be approved by the advisory committee prior to the beginning of the third semester of enrollment.
- It is recommended that the student be a teaching assistant or instructor for at least one semester.

- Students may request a maximum of 15 graduate credits taken at UNLV prior to admission be included in the graduate degree program, providing those credits were not used to fulfill undergraduate requirements and a grade of B (3.00) or higher was achieved.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 2 Requirements: Post-Bachelor's - Geophysics Track

Total Credits Required: 60

Course Requirements

- Required Course – Credits: 3
  - GEOL 701 - Research Methods in Geoscience
- Core Course – Credits: 3
  - Complete one of the following courses:
    - CEE 636 - Engineering Geophysics
    - GEOL 645 - Geophysical Methods
- Additional Core Course – Credits: 3
  - Complete one of the following courses:
    - ECG 780 - Digital Signal Processing
    - GEOL 793 - Independent Study and Research
- Geophysics Courses – Credits: 9
  - Complete 9 credits in three or more of the following courses, or other advisor-approved courses.
    - BIOL 618 - Microbial Ecology
    - CEE 634 - Rock Mechanics
    - CEE 636 - Engineering Geophysics
    - CEE 676 - Earthquake Engineering
    - CEE 737 - Soil Dynamics and Earthquake Engineering
    - CEE 775 - Seismic Response of Structures
    - GEOL 630 - Geographic Information Systems (GIS): Theory and Applications
    - GEOL 643 - Plate Tectonics
    - GEOL 644 - Tectonics of Orogenic Belts
    - GEOL 646 - Geologic Applications in Remote Sensing
    - GEOL 678 - Hydrogeochemistry
    - GEOL 688 - Microtechniques in Geoscience
    - GEOL 716 - Geostatistics
    - GEOL 744 - Tectonics and Structures
    - GEOL 745 - Advanced Structural Geology
    - GEOL 746 - Strain and Microstructural Analysis
    - GEOL 747 - Geological Evolution of Western North America
    - GEOL 770 - Sedimentary Basins
    - GEOL 772 - Reflection Seismic Data Interpretation
    - GEOL 773 - Seminar in Geophysics
- Elective Courses – Credits: 30

- Complete 30 credits from the following list of courses, or other advisor-approved courses that are appropriate for the course of study.
    - BIOL 618 - Microbial Ecology
    - CEE 634 - Rock Mechanics
    - CEE 636 - Engineering Geophysics
    - CEE 676 - Earthquake Engineering
    - CEE 737 - Soil Dynamics and Earthquake Engineering
    - CEE 775 - Seismic Response of Structures
    - GEOL 630 - Geographic Information Systems (GIS): Theory and Applications
    - GEOL 643 - Plate Tectonics
    - GEOL 644 - Tectonics of Orogenic Belts
    - GEOL 646 - Geologic Applications in Remote Sensing
    - GEOL 678 - Hydrogeochemistry
    - GEOL 688 - Microtechniques in Geoscience
    - GEOL 716 - Geostatistics
    - GEOL 744 - Tectonics and Structures
    - GEOL 745 - Advanced Structural Geology
    - GEOL 746 - Strain and Microstructural Analysis
    - GEOL 747 - Geological Evolution of Western North America
    - GEOL 770 - Sedimentary Basins
    - GEOL 772 - Reflection Seismic Data Interpretation
    - GEOL 773 - Seminar in Geophysics

- Dissertation – Credits: 12
    - GEOL 799 - Dissertation

Degree Requirements

- Students must complete a minimum of 60 credit hours with a minimum GPA of 3.00.
- A minimum of 24 of the 60 credits required must be at the 700-level.
- Although more course work and dissertation credits may be taken, only 12 credits of Dissertation, and 48 course credits will be counted toward the degree program.
- Doctoral students are encouraged to take courses from outside of geoscience; however, a minimum of 15 credits must be geoscience (GEOL) courses.
- A maximum of three credits of Independent Study are permitted, except in special circumstances in which case permission from the doctoral advising committee, the department Graduate Coordinator and the department chair is required.
- Satisfactory progress toward meeting the degree requirements is required of all candidates. Satisfactory progress is defined as, at a minimum:
    - Maintenance of at least a 3.00 grade point average in all graduate-level courses. Two grades of B- are permitted in the degree program as long as the GPA remains at or above 3.00. One grade of C+ or lower results in academic probation even if the overall GPA is above 3.0. Two grades of C+ or lower will result in automatic suspension from the program.
    - Selecting a dissertation advisor and committee. The advisor must be selected before the end of the first semester and the committee before the end of the second semester.
    - Scheduling of an interview with the advisor either during or before the first semester. If an advisor is not selected, a temporary advisor will be assigned by the graduate coordinator. The purpose of the interview is to develop a plan of course work for the first year.
    - In consultation with his/her advisor, a student will organize a thesis committee of at least three departmental members. In addition, a fourth member from outside the department,

known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.

  - Scheduling of a diagnostic interview with the Advisory Committee before the end of the 2nd semester. The purpose of the interview is to develop a list of recommended courses and design the student's degree program, which must be submitted prior to completing 16 credits of course work toward the degree.
  - Preparation of a dissertation proposal and satisfactory performance on a Proposal Defense Examination. This examination must be completed prior to the end of the third semester. The Proposal Defense Examination focuses on the dissertation proposal and the student's ability to perform the research. It includes a formal oral presentation of the student's dissertation proposal, research to date, and questions by the dissertation advisory committee on the dissertation topic. The Proposal Defense Examination is to be taken prior to the Comprehensive Examination.
  - Satisfactory performance on the Comprehensive Examination. Ph.D. students must have a basic knowledge of Physical Geology in addition to a comprehensive knowledge of three fields of geosciences (see Department of Geoscience Graduate Student Guidelines for recommended fields for each Ph.D. Emphasis). The format and content of the exam will be determined by the student's doctoral advisory committee with approval of the department graduate coordinator. The Comprehensive Examination will be taken either the semester after all course work is completed or before the end of the fifth semester, whichever comes first. The examination will be oral. In exceptional circumstances, as determined by the student's dissertation committee and the graduate coordinator, the examination will consist of both oral and written components. Students who fail to pass the Comprehensive Examination or Proposal Defense on the first attempt must successfully complete a second examination (as specified by the doctoral advisory committee) within the next six months to remain in the program. Students who entered the program with a baccalaureate degree and who fail the second examination may be allowed to continue as a Master of Science student with the consent of the doctoral advising committee. Students who entered the program with a master's degree who fail the examination a second time will be separated from the program. A student who has successfully passed both the Proposal Defense and Comprehensive Examinations will be admitted to candidacy for the Ph.D. degree.
  - Satisfactory performance on a final examination will consist of the presentation and defense of the dissertation research. The defense will consist of an oral presentation open to the public, a short period of questions from the public, a closed session of questions from the doctoral advising committee, and a closed deliberation and vote by just the advisory committee members. Any graduate faculty member may attend the closed session of questions of the defense.
- Using Degree Audit as a guide, a degree program must be approved by the advisory committee prior to the beginning of the third semester of enrollment.
- It is recommended that the student be a teaching assistant or instructor for at least one semester.
- Students may request a maximum of 15 graduate credits taken at UNLV prior to admission be included in the graduate degree program, providing those credits were not used to fulfill undergraduate requirements and a grade of B (3.00) or higher was achieved.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 3 Requirements: Post-Bachelor's - Soil Science Track

Total Credits Required: 60

Course Requirements

- Required Course – Credits: 3
  - GEOL 701 - Research Methods in Geoscience
- Core Courses – Credits: 6
  - GEOL 610 - Soil Classification and Resource Management
  - GEOL 786 - Soils Applications: Paleoclimate, Neotectonics, Archeology
- Elective Courses – Credits: 39
  - Complete 39 credits from the following list of courses, or other advisor-approved courses that are appropriate for the course of study.
    - BIOL 618 - Microbial Ecology
    - BIOL 745 - Arid Zone Soils
    - GEOL 630 - Geographic Information Systems (GIS): Theory and Applications
    - GEOL 646 - Geologic Applications in Remote Sensing
    - GEOL 688 - Microtechniques in Geoscience
    - GEOL 712 - Watershed Hydrology
    - GEOL 716 - Geostatistics
    - GEOL 719 - Vadose Zone Hydrology
    - GEOL 735 - Seminar in Environmental Geology
    - GEOL 740 - Arid Zone Soils
    - GEOL 744 - Tectonics and Structures
    - GEOL 760 - Advanced Spatial Modeling with GIS
    - GEOL 770 - Sedimentary Basins
    - GEOL 776 - Paleosols Records of Past Landscapes
- Dissertation – Credits: 12
  - GEOL 799 - Dissertation

Degree Requirements

- Students must complete a minimum of 60 credit hours with a minimum GPA of 3.00.
- A minimum of 24 of the 60 credits required must be at the 700-level.
- Although more course work and dissertation credits may be taken, only 12 credits of Dissertation, and 48 course credits will be counted toward the degree program.
- Doctoral students are encouraged to take courses from outside of geoscience; however, a minimum of 15 credits must be geoscience (GEOL) courses.
- A maximum of three credits of Independent Study are permitted, except in special circumstances in which case permission from the doctoral advising committee, the department Graduate Coordinator and the department chair is required.
- Satisfactory progress toward meeting the degree requirements is required of all candidates. Satisfactory progress is defined as, at a minimum:
  - Maintenance of at least a 3.00 grade point average in all graduate-level courses. Two grades of B- are permitted in the degree program as long as the GPA remains at or above 3.00. One grade of C+ or lower results in academic probation even if the overall GPA is above 3.0. Two grades of C+ or lower will result in automatic suspension from the program.

- Selecting a dissertation advisor and committee. The advisor must be selected before the end of the first semester and the committee before the end of the second semester.
- Scheduling of an interview with the advisor either during or before the first semester. If an advisor is not selected, a temporary advisor will be assigned by the graduate coordinator. The purpose of the interview is to develop a plan of course work for the first year.
- In consultation with his/her advisor, a student will organize a thesis committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.
- Scheduling of a diagnostic interview with the Advisory Committee before the end of the 2nd semester. The purpose of the interview is to develop a list of recommended courses and design the student's degree program, which must be submitted prior to completing 16 credits of course work toward the degree.
- Preparation of a dissertation proposal and satisfactory performance on a Proposal Defense Examination. This examination must be completed prior to the end of the third semester. The Proposal Defense Examination focuses on the dissertation proposal and the student's ability to perform the research. It includes a formal oral presentation of the student's dissertation proposal, research to date, and questions by the dissertation advisory committee on the dissertation topic. The Proposal Defense Examination is to be taken prior to the Comprehensive Examination.
- Satisfactory performance on the Comprehensive Examination. Ph.D. students must have a basic knowledge of Physical Geology in addition to a comprehensive knowledge of three fields of geosciences (see Department of Geoscience Graduate Student Guidelines for recommended fields for each Ph.D. Emphasis). The format and content of the exam will be determined by the student's doctoral advisory committee with approval of the department graduate coordinator. The Comprehensive Examination will be taken either the semester after all course work is completed or before the end of the fifth semester, whichever comes first. The examination will be oral. In exceptional circumstances, as determined by the student's dissertation committee and the graduate coordinator, the examination will consist of both oral and written components. Students who fail to pass the Comprehensive Examination or Proposal Defense on the first attempt must successfully complete a second examination (as specified by the doctoral advisory committee) within the next six months to remain in the program. Students who entered the program with a baccalaureate degree and who fail the second examination may be allowed to continue as a Master of Science student with the consent of the doctoral advising committee. Students who entered the program with a master's degree who fail the examination a second time will be separated from the program. A student who has successfully passed both the Proposal Defense and Comprehensive Examinations will be admitted to candidacy for the Ph.D. degree.
- Satisfactory performance on a final examination will consist of the presentation and defense of the dissertation research. The defense will consist of an oral presentation open to the public, a short period of questions from the public, a closed session of questions from the doctoral advising committee, and a closed deliberation and vote by just the advisory committee members. Any graduate faculty member may attend the closed session of questions of the defense.

- Using Degree Audit as a guide, a degree program must be approved by the advisory committee prior to the beginning of the third semester of enrollment.
- It is recommended that the student be a teaching assistant or instructor for at least one semester.

- Students may request a maximum of 15 graduate credits taken at UNLV prior to admission be included in the graduate degree program, providing those credits were not used to fulfill undergraduate requirements and a grade of B (3.00) or higher was achieved.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 4 Requirements: Post-Bachelor's - Hydrogeology Track

Total Credits Required: 60

Course Requirements

- Required Course – Credits: 3
  - GEOL 701 - Research Methods in Geoscience
- Elective Courses – Credits: 45
  - Complete 45 credits from the following list of courses, or other advisor-approved courses that are appropriate for the course of study.
    - BIOL 618 - Microbial Ecology
    - BIOL 745 - Arid Zone Soils
    - GEOL 630 - Geographic Information Systems (GIS): Theory and Applications
    - GEOL 646 - Geologic Applications in Remote Sensing
    - GEOL 674 - Hydrogeology
    - GEOL 678 - Hydrogeochemistry
    - GEOL 688 - Microtechniques in Geoscience
    - GEOL 709 - Field Methods in Hydrogeology
    - GEOL 711 - Principles of Hydrology and Hydraulics
    - GEOL 712 - Watershed Hydrology
    - GEOL 715 - Advanced Hydrogeology
    - GEOL 716 - Geostatistics
    - GEOL 719 - Vadose Zone Hydrology
    - GEOL 735 - Seminar in Environmental Geology
    - GEOL 740 - Arid Zone Soils
    - GEOL 744 - Tectonics and Structures
    - GEOL 760 - Advanced Spatial Modeling with GIS
    - GEOL 765 - Seminar in Stratigraphy
    - GEOL 770 - Sedimentary Basins
    - GEOL 776 - Paleosols Records of Past Landscapes
    - GEOL 785 - Seminar in Sedimentology
    - GEOL 792 - Seminar in Hydroscience
- Dissertation – Credits: 12
  - GEOL 799 - Dissertation

Degree Requirements

- Students must complete a minimum of 60 credit hours with a minimum GPA of 3.00.
- A minimum of 24 of the 60 credits required must be at the 700-level.

- Although more course work and dissertation credits may be taken, only 12 credits of Dissertation, and 48 course credits will be counted toward the degree program.
- Doctoral students are encouraged to take courses from outside of geoscience; however, a minimum of 15 credits must be geoscience (GEOL) courses.
- A maximum of three credits of Independent Study are permitted, except in special circumstances in which case permission from the doctoral advising committee, the department Graduate Coordinator and the department chair is required.
- Satisfactory progress toward meeting the degree requirements is required of all candidates. Satisfactory progress is defined as, at a minimum:
    - Maintenance of at least a 3.00 grade point average in all graduate-level courses. Two grades of B- are permitted in the degree program as long as the GPA remains at or above 3.00. One grade of C+ or lower results in academic probation even if the overall GPA is above 3.0. Two grades of C+ or lower will result in automatic suspension from the program.
    - Selecting a dissertation advisor and committee. The advisor must be selected before the end of the first semester and the committee before the end of the second semester.
    - Scheduling of an interview with the advisor either during or before the first semester. If an advisor is not selected, a temporary advisor will be assigned by the graduate coordinator. The purpose of the interview is to develop a plan of course work for the first year.
    - In consultation with his/her advisor, a student will organize a thesis committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.
    - Scheduling of a diagnostic interview with the Advisory Committee before the end of the 2nd semester. The purpose of the interview is to develop a list of recommended courses and design the student's degree program, which must be submitted prior to completing 16 credits of course work toward the degree.
    - Preparation of a dissertation proposal and satisfactory performance on a Proposal Defense Examination. This examination must be completed prior to the end of the third semester. The Proposal Defense Examination focuses on the dissertation proposal and the student's ability to perform the research. It includes a formal oral presentation of the student's dissertation proposal, research to date, and questions by the dissertation advisory committee on the dissertation topic. The Proposal Defense Examination is to be taken prior to the Comprehensive Examination.
    - Satisfactory performance on the Comprehensive Examination. Ph.D. students must have a basic knowledge of Physical Geology in addition to a comprehensive knowledge of three fields of geosciences (see Department of Geoscience Graduate Student Guidelines for recommended fields for each Ph.D. Emphasis). The format and content of the exam will be determined by the student's doctoral advisory committee with approval of the department graduate coordinator. The Comprehensive Examination will be taken either the semester after all course work is completed or before the end of the fifth semester, whichever comes first. The examination will be oral. In exceptional circumstances, as determined by the student's dissertation committee and the graduate coordinator, the examination will consist of both oral and written components. Students who fail to pass the Comprehensive Examination or Proposal Defense on the first attempt must successfully complete a second examination (as specified by the doctoral advisory committee) within the next six months to remain in the program. Students who entered the program with a baccalaureate degree and who fail the second examination may be allowed to continue as a Master of Science student with the

consent of the doctoral advising committee. Students who entered the program with a master's degree who fail the examination a second time will be separated from the program. A student who has successfully passed both the Proposal Defense and Comprehensive Examinations will be admitted to candidacy for the Ph.D. degree.
    - Satisfactory performance on a final examination will consist of the presentation and defense of the dissertation research. The defense will consist of an oral presentation open to the public, a short period of questions from the public, a closed session of questions from the doctoral advising committee, and a closed deliberation and vote by just the advisory committee members. Any graduate faculty member may attend the closed session of questions of the defense.
- Using Degree Audit as a guide, a degree program must be approved by the advisory committee prior to the beginning of the third semester of enrollment.
- It is recommended that the student be a teaching assistant or instructor for at least one semester.
- Students may request a maximum of 15 graduate credits taken at UNLV prior to admission be included in the graduate degree program, providing those credits were not used to fulfill undergraduate requirements and a grade of B (3.00) or higher was achieved.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 5 Requirements: Post-Master's - Geology Track

Total Credits Required: 36

Course Requirements

- Required Course – Credits: 3
    - GEOL 701 - Research Methods in Geoscience
- Elective Courses – Credits: 21
    - Complete 21 credits of 600- or 700-level GEOL courses, or other advisor-approved courses.
- Dissertation – Credits: 12
    - GEOL 799 - Dissertation

Degree Requirements

- Students must complete a minimum of 36 credit hours with a minimum GPA of 3.00.
- A minimum of 12 of the 36 credits required must be at the 700-level.
- Although more course work and dissertation credits may be taken, only 12 credits of Dissertation, and 24 course credits will be counted toward the degree program.
- Doctoral students are encouraged to take courses from outside of geoscience; however, a minimum of 15 credits must be geoscience (GEOL) courses.
- A maximum of three credits of Independent Study are permitted, except in special circumstances in which case permission from the doctoral advising committee, the department Graduate Coordinator and the department chair is required.
- Satisfactory progress toward meeting the degree requirements is required of all candidates. Satisfactory progress is defined as, at a minimum:

- Maintenance of at least a 3.00 grade point average in all graduate-level courses. Two grades of B- are permitted in the degree program as long as the GPA remains at or above 3.00. One grade of C+ or lower results in academic probation even if the overall GPA is above 3.0. Two grades of C+ or lower will result in automatic suspension from the program.
- Selecting a dissertation advisor and committee. The advisor must be selected before the end of the first semester and the committee before the end of the second semester.
- Scheduling of an interview with the advisor either during or before the first semester. If an advisor is not selected, a temporary advisor will be assigned by the graduate coordinator. The purpose of the interview is to develop a plan of course work for the first year.
- In consultation with his/her advisor, a student will organize a thesis committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.
- Scheduling of a diagnostic interview with the Advisory Committee before the end of the 2nd semester. The purpose of the interview is to develop a list of recommended courses and design the student's degree program, which must be submitted prior to completing 16 credits of course work toward the degree.
- Preparation of a dissertation proposal and satisfactory performance on a Proposal Defense Examination. This examination must be completed prior to the end of the third semester. The Proposal Defense Examination focuses on the dissertation proposal and the student's ability to perform the research. It includes a formal oral presentation of the student's dissertation proposal, research to date, and questions by the dissertation advisory committee on the dissertation topic. The Proposal Defense Examination is to be taken prior to the Comprehensive Examination.
- Satisfactory performance on the Comprehensive Examination. Ph.D. students must have a basic knowledge of Physical Geology in addition to a comprehensive knowledge of three fields of geosciences (see Department of Geoscience Graduate Student Guidelines for recommended fields for each Ph.D. Emphasis). The format and content of the exam will be determined by the student's doctoral advisory committee with approval of the department graduate coordinator. The Comprehensive Examination will be taken either the semester after all course work is completed or before the end of the fifth semester, whichever comes first. The examination will be oral. In exceptional circumstances, as determined by the student's dissertation committee and the graduate coordinator, the examination will consist of both oral and written components. Students who fail to pass the Comprehensive Examination or Proposal Defense on the first attempt must successfully complete a second examination (as specified by the doctoral advisory committee) within the next six months to remain in the program. Students who entered the program with a baccalaureate degree and who fail the second examination may be allowed to continue as a Master of Science student with the consent of the doctoral advising committee. Students who entered the program with a master's degree who fail the examination a second time will be separated from the program. A student who has successfully passed both the Proposal Defense and Comprehensive Examinations will be admitted to candidacy for the Ph.D. degree.
- Satisfactory performance on a final examination will consist of the presentation and defense of the dissertation research. The defense will consist of an oral presentation open to the public, a short period of questions from the public, a closed session of questions from the doctoral advising committee, and a closed deliberation and vote by just the advisory committee members. Any graduate faculty member may attend the closed session of questions of the defense.

- Using Degree Audit as a guide, a degree program must be approved by the advisory committee prior to the beginning of the third semester of enrollment.
- It is recommended that the student be a teaching assistant or instructor for at least one semester.
- Students may request a maximum of 15 graduate credits taken at UNLV prior to admission be included in the graduate degree program, providing those credits were not used to fulfill undergraduate requirements and a grade of B (3.00) or higher was achieved.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 6 Requirements: Post-Master's - Geophysics Track

Total Credits Required: 36

Course Requirements

- Required Course – Credits: 3
  - GEOL 701 - Research Methods in Geoscience
- Core Course – Credits: 3
  - Complete one of the following courses:
    - CEE 636 - Engineering Geophysics
    - GEOL 645 - Geophysical Methods
- Additional Core Course – Credits: 3
  - Complete one of the following courses:
    - ECG 780 - Digital Signal Processing
    - GEOL 793 - Independent Study and Research
- Geophysics Courses – Credits: 9
  - Complete 9 credits in three or more of the following courses, or other advisor-approved courses.
    - BIOL 618 - Microbial Ecology
    - CEE 634 - Rock Mechanics
    - CEE 636 - Engineering Geophysics
    - CEE 676 - Earthquake Engineering
    - CEE 737 - Soil Dynamics and Earthquake Engineering
    - CEE 775 - Seismic Response of Structures
    - GEOL 630 - Geographic Information Systems (GIS): Theory and Applications
    - GEOL 643 - Plate Tectonics
    - GEOL 644 - Tectonics of Orogenic Belts
    - GEOL 646 - Geologic Applications in Remote Sensing
    - GEOL 678 - Hydrogeochemistry
    - GEOL 688 - Microtechniques in Geoscience
    - GEOL 716 - Geostatistics
    - GEOL 744 - Tectonics and Structures
    - GEOL 745 - Advanced Structural Geology
    - GEOL 746 - Strain and Microstructural Analysis
    - GEOL 747 - Geological Evolution of Western North America

        - GEOL 770 - Sedimentary Basins
        - GEOL 772 - Reflection Seismic Data Interpretation
        - GEOL 773 - Seminar in Geophysics
- Elective Courses – Credits: 6
    - Complete 6 credits from the following list of courses, or other advisor-approved courses that are appropriate for the course of study.
        - BIOL 618 - Microbial Ecology
        - CEE 634 - Rock Mechanics
        - CEE 636 - Engineering Geophysics
        - CEE 676 - Earthquake Engineering
        - CEE 737 - Soil Dynamics and Earthquake Engineering
        - CEE 775 - Seismic Response of Structures
        - GEOL 630 - Geographic Information Systems (GIS): Theory and Applications
        - GEOL 643 - Plate Tectonics
        - GEOL 644 - Tectonics of Orogenic Belts
        - GEOL 646 - Geologic Applications in Remote Sensing
        - GEOL 678 - Hydrogeochemistry
        - GEOL 688 - Microtechniques in Geoscience
        - GEOL 716 - Geostatistics
        - GEOL 744 - Tectonics and Structures
        - GEOL 745 - Advanced Structural Geology
        - GEOL 746 - Strain and Microstructural Analysis
        - GEOL 747 - Geological Evolution of Western North America
        - GEOL 770 - Sedimentary Basins
        - GEOL 772 - Reflection Seismic Data Interpretation
        - GEOL 773 - Seminar in Geophysics
- Dissertation – Credits: 12
    - GEOL 799 - Dissertation

Degree Requirements

- Students must complete a minimum of 36 credit hours with a minimum GPA of 3.00.
- A minimum of 12 of the 36 credits required must be at the 700-level.
- Although more course work and dissertation credits may be taken, only 12 credits of Dissertation, and 24 course credits will be counted toward the degree program.
- Doctoral students are encouraged to take courses from outside of geoscience; however, a minimum of 15 credits must be geoscience (GEOL) courses.
- A maximum of three credits of Independent Study are permitted, except in special circumstances in which case permission from the doctoral advising committee, the department Graduate Coordinator and the department chair is required.
- Satisfactory progress toward meeting the degree requirements is required of all candidates. Satisfactory progress is defined as, at a minimum:
    - Maintenance of at least a 3.00 grade point average in all graduate-level courses. Two grades of B- are permitted in the degree program as long as the GPA remains at or above 3.00. One grade of C+ or lower results in academic probation even if the overall GPA is above 3.0. Two grades of C+ or lower will result in automatic suspension from the program.
    - Selecting a dissertation advisor and committee. The advisor must be selected before the end of the first semester and the committee before the end of the second semester.

    - Scheduling of an interview with the advisor either during or before the first semester. If an advisor is not selected, a temporary advisor will be assigned by the graduate coordinator. The purpose of the interview is to develop a plan of course work for the first year.
    - In consultation with his/her advisor, a student will organize a thesis committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.
    - Scheduling of a diagnostic interview with the Advisory Committee before the end of the 2nd semester. The purpose of the interview is to develop a list of recommended courses and design the student's degree program, which must be submitted prior to completing 16 credits of course work toward the degree.
    - Preparation of a dissertation proposal and satisfactory performance on a Proposal Defense Examination. This examination must be completed prior to the end of the third semester. The Proposal Defense Examination focuses on the dissertation proposal and the student's ability to perform the research. It includes a formal oral presentation of the student's dissertation proposal, research to date, and questions by the dissertation advisory committee on the dissertation topic. The Proposal Defense Examination is to be taken prior to the Comprehensive Examination.
    - Satisfactory performance on the Comprehensive Examination. Ph.D. students must have a basic knowledge of Physical Geology in addition to a comprehensive knowledge of three fields of geosciences (see Department of Geoscience Graduate Student Guidelines for recommended fields for each Ph.D. Emphasis). The format and content of the exam will be determined by the student's doctoral advisory committee with approval of the department graduate coordinator. The Comprehensive Examination will be taken either the semester after all course work is completed or before the end of the fifth semester, whichever comes first. The examination will be oral. In exceptional circumstances, as determined by the student's dissertation committee and the graduate coordinator, the examination will consist of both oral and written components. Students who fail to pass the Comprehensive Examination or Proposal Defense on the first attempt must successfully complete a second examination (as specified by the doctoral advisory committee) within the next six months to remain in the program. Students who entered the program with a baccalaureate degree and who fail the second examination may be allowed to continue as a Master of Science student with the consent of the doctoral advising committee. Students who entered the program with a master's degree who fail the examination a second time will be separated from the program. A student who has successfully passed both the Proposal Defense and Comprehensive Examinations will be admitted to candidacy for the Ph.D. degree.
    - Satisfactory performance on a final examination will consist of the presentation and defense of the dissertation research. The defense will consist of an oral presentation open to the public, a short period of questions from the public, a closed session of questions from the doctoral advising committee, and a closed deliberation and vote by just the advisory committee members. Any graduate faculty member may attend the closed session of questions of the defense.
- Using Degree Audit as a guide, a degree program must be approved by the advisory committee prior to the beginning of the third semester of enrollment.
- It is recommended that the student be a teaching assistant or instructor for at least one semester.

- Students may request a maximum of 15 graduate credits taken at UNLV prior to admission be included in the graduate degree program, providing those credits were not used to fulfill undergraduate requirements and a grade of B (3.00) or higher was achieved.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 7 Requirements: Post-Master's - Soil Science Track

Total Credits Required: 36

Course Requirements

- Required Courses – Credits: 9
  - GEOL 610 - Soil Classification and Resource Management
  - GEOL 701 - Research Methods in Geoscience
  - GEOL 786 - Soils Applications: Paleoclimate, Neotectonics, Archeology
- Elective Courses – Credits: 15
  - Complete 15 credits from the following list of courses, or other advisor-approved courses that are appropriate for the course of study.
    - BIOL 618 - Microbial Ecology
    - BIOL 745 - Arid Zone Soils
    - GEOL 630 - Geographic Information Systems (GIS): Theory and Applications
    - GEOL 646 - Geologic Applications in Remote Sensing
    - GEOL 688 - Microtechniques in Geoscience
    - GEOL 712 - Watershed Hydrology
    - GEOL 716 - Geostatistics
    - GEOL 719 - Vadose Zone Hydrology
    - GEOL 735 - Seminar in Environmental Geology
    - GEOL 740 - Arid Zone Soils
    - GEOL 744 - Tectonics and Structures
    - GEOL 760 - Advanced Spatial Modeling with GIS
    - GEOL 770 - Sedimentary Basins
    - GEOL 776 - Paleosols Records of Past Landscapes
- Dissertation – Credits: 12
  - GEOL 799 - Dissertation

Degree Requirements

- Students must complete a minimum of 36 credit hours with a minimum GPA of 3.00.
- A minimum of 12 of the 36 credits required must be at the 700-level.
- Although more course work and dissertation credits may be taken, only 12 credits of Dissertation, and 24 course credits will be counted toward the degree program.
- Doctoral students are encouraged to take courses from outside of geoscience; however, a minimum of 15 credits must be geoscience (GEOL) courses.

- A maximum of three credits of Independent Study are permitted, except in special circumstances in which case permission from the doctoral advising committee, the department Graduate Coordinator and the department chair is required.
- Satisfactory progress toward meeting the degree requirements is required of all candidates. Satisfactory progress is defined as, at a minimum:
    - Maintenance of at least a 3.00 grade point average in all graduate-level courses. Two grades of B- are permitted in the degree program as long as the GPA remains at or above 3.00. One grade of C+ or lower results in academic probation even if the overall GPA is above 3.0. Two grades of C+ or lower will result in automatic suspension from the program.
    - Selecting a dissertation advisor and committee. The advisor must be selected before the end of the first semester and the committee before the end of the second semester.
    - Scheduling of an interview with the advisor either during or before the first semester. If an advisor is not selected, a temporary advisor will be assigned by the graduate coordinator. The purpose of the interview is to develop a plan of course work for the first year.
    - In consultation with his/her advisor, a student will organize a thesis committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.
    - Scheduling of a diagnostic interview with the Advisory Committee before the end of the 2nd semester. The purpose of the interview is to develop a list of recommended courses and design the student's degree program, which must be submitted prior to completing 16 credits of course work toward the degree.
    - Preparation of a dissertation proposal and satisfactory performance on a Proposal Defense Examination. This examination must be completed prior to the end of the third semester. The Proposal Defense Examination focuses on the dissertation proposal and the student's ability to perform the research. It includes a formal oral presentation of the student's dissertation proposal, research to date, and questions by the dissertation advisory committee on the dissertation topic. The Proposal Defense Examination is to be taken prior to the Comprehensive Examination.
    - Satisfactory performance on the Comprehensive Examination. Ph.D. students must have a basic knowledge of Physical Geology in addition to a comprehensive knowledge of three fields of geosciences (see Department of Geoscience Graduate Student Guidelines for recommended fields for each Ph.D. Emphasis). The format and content of the exam will be determined by the student's doctoral advisory committee with approval of the department graduate coordinator. The Comprehensive Examination will be taken either the semester after all course work is completed or before the end of the fifth semester, whichever comes first. The examination will be oral. In exceptional circumstances, as determined by the student's dissertation committee and the graduate coordinator, the examination will consist of both oral and written components. Students who fail to pass the Comprehensive Examination or Proposal Defense on the first attempt must successfully complete a second examination (as specified by the doctoral advisory committee) within the next six months to remain in the program. Students who entered the program with a baccalaureate degree and who fail the second examination may be allowed to continue as a Master of Science student with the consent of the doctoral advising committee. Students who entered the program with a master's degree who fail the examination a second time will be separated from the program. A student who has successfully passed both the Proposal Defense and Comprehensive Examinations will be admitted to candidacy for the Ph.D. degree.

        - Satisfactory performance on a final examination will consist of the presentation and defense of the dissertation research. The defense will consist of an oral presentation open to the public, a short period of questions from the public, a closed session of questions from the doctoral advising committee, and a closed deliberation and vote by just the advisory committee members. Any graduate faculty member may attend the closed session of questions of the defense.
- Using Degree Audit as a guide, a degree program must be approved by the advisory committee prior to the beginning of the third semester of enrollment.
- It is recommended that the student be a teaching assistant or instructor for at least one semester.
- Students may request a maximum of 15 graduate credits taken at UNLV prior to admission be included in the graduate degree program, providing those credits were not used to fulfill undergraduate requirements and a grade of B (3.00) or higher was achieved.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 8 Requirements: Post-Master's - Hydrogeology Track

Total Credits Required: 36

Course Requirements

- Required Course – Credits: 3
    - GEOL 701 - Research Methods in Geoscience
- Elective Courses – Credits: 21
    - Complete 21 credits from the following list of courses, or other advisor-approved courses that are appropriate for the course of study.
        - BIOL 618 - Microbial Ecology
        - BIOL 745 - Arid Zone Soils
        - GEOL 630 - Geographic Information Systems (GIS): Theory and Applications
        - GEOL 646 - Geologic Applications in Remote Sensing
        - GEOL 674 - Hydrogeology
        - GEOL 678 - Hydrogeochemistry
        - GEOL 688 - Microtechniques in Geoscience
        - GEOL 709 - Field Methods in Hydrogeology
        - GEOL 711 - Principles of Hydrology and Hydraulics
        - GEOL 712 - Watershed Hydrology
        - GEOL 715 - Advanced Hydrogeology
        - GEOL 716 - Geostatistics
        - GEOL 719 - Vadose Zone Hydrology
        - GEOL 735 - Seminar in Environmental Geology
        - GEOL 740 - Arid Zone Soils
        - GEOL 744 - Tectonics and Structures
        - GEOL 760 - Advanced Spatial Modeling with GIS
        - GEOL 765 - Seminar in Stratigraphy
        - GEOL 770 - Sedimentary Basins
        - GEOL 776 - Paleosols Records of Past Landscapes

        - GEOL 785 - Seminar in Sedimentology
        - GEOL 792 - Seminar in Hydroscience
- Dissertation – Credits: 12
    - GEOL 799 - Dissertation

Degree Requirements

- Students must complete a minimum of 36 credit hours with a minimum GPA of 3.00.
- A minimum of 12 of the 36 credits required must be at the 700-level.
- Although more course work and dissertation credits may be taken, only 12 credits of Dissertation, and 24 course credits will be counted toward the degree program.
- Doctoral students are encouraged to take courses from outside of geoscience; however, a minimum of 15 credits must be geoscience (GEOL) courses.
- A maximum of three credits of Independent Study are permitted, except in special circumstances in which case permission from the doctoral advising committee, the department Graduate Coordinator and the department chair is required.
- Satisfactory progress toward meeting the degree requirements is required of all candidates. Satisfactory progress is defined as, at a minimum:
    - Maintenance of at least a 3.00 grade point average in all graduate-level courses. Two grades of B- are permitted in the degree program as long as the GPA remains at or above 3.00. One grade of C+ or lower results in academic probation even if the overall GPA is above 3.0. Two grades of C+ or lower will result in automatic suspension from the program.
    - Selecting a dissertation advisor and committee. The advisor must be selected before the end of the first semester and the committee before the end of the second semester.
    - Scheduling of an interview with the advisor either during or before the first semester. If an advisor is not selected, a temporary advisor will be assigned by the graduate coordinator. The purpose of the interview is to develop a plan of course work for the first year.
    - In consultation with his/her advisor, a student will organize a thesis committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.
    - Scheduling of a diagnostic interview with the Advisory Committee before the end of the 2nd semester. The purpose of the interview is to develop a list of recommended courses and design the student's degree program, which must be submitted prior to completing 16 credits of course work toward the degree.
    - Preparation of a dissertation proposal and satisfactory performance on a Proposal Defense Examination. This examination must be completed prior to the end of the third semester. The Proposal Defense Examination focuses on the dissertation proposal and the student's ability to perform the research. It includes a formal oral presentation of the student's dissertation proposal, research to date, and questions by the dissertation advisory committee on the dissertation topic. The Proposal Defense Examination is to be taken prior to the Comprehensive Examination.
    - Satisfactory performance on the Comprehensive Examination. Ph.D. students must have a basic knowledge of Physical Geology in addition to a comprehensive knowledge of three fields of geosciences (see Department of Geoscience Graduate Student Guidelines for recommended fields for each Ph.D. Emphasis). The format and content of the exam will be determined by the student's doctoral advisory committee with approval of the department graduate coordinator. The Comprehensive Examination will be taken either the semester after all course work is completed or before the end of the fifth semester, whichever comes first. The examination will be oral. In

exceptional circumstances, as determined by the student's dissertation committee and the graduate coordinator, the examination will consist of both oral and written components. Students who fail to pass the Comprehensive Examination or Proposal Defense on the first attempt must successfully complete a second examination (as specified by the doctoral advisory committee) within the next six months to remain in the program. Students who entered the program with a baccalaureate degree and who fail the second examination may be allowed to continue as a Master of Science student with the consent of the doctoral advising committee. Students who entered the program with a master's degree who fail the examination a second time will be separated from the program. A student who has successfully passed both the Proposal Defense and Comprehensive Examinations will be admitted to candidacy for the Ph.D. degree.

  - Satisfactory performance on a final examination will consist of the presentation and defense of the dissertation research. The defense will consist of an oral presentation open to the public, a short period of questions from the public, a closed session of questions from the doctoral advising committee, and a closed deliberation and vote by just the advisory committee members. Any graduate faculty member may attend the closed session of questions of the defense.

- Using Degree Audit as a guide, a degree program must be approved by the advisory committee prior to the beginning of the third semester of enrollment.
- It is recommended that the student be a teaching assistant or instructor for at least one semester.
- Students may request a maximum of 15 graduate credits taken at UNLV prior to admission be included in the graduate degree program, providing those credits were not used to fulfill undergraduate requirements and a grade of B (3.00) or higher was achieved.

Graduation Requirements

See Plan Graduation Requirements below.

Plan Graduation Requirements

- The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
- The student must submit and successfully defend his/her dissertation by the posted deadline. The defense must be advertised and is open to the public.
- The student must submit his/her approved, properly formatted hard-copy dissertation to the Graduate College, and submit the approved electronic version to ProQuest by the posted deadline.

Geoscience Courses

GEOG 621 - Climatology
Credits 3
Physical characteristics of the atmosphere. World climatic classification. Local atmospheric field study.
Prerequisites GEOG 103 or consent of instructor.

GEOL 610 - Soil Classification and Resource Management
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 620 - Introduction to X-ray Diffraction and X-ray Spectrometry Methods
Introduction to the principles and methods of x-ray analysis as applied to the study of minerals. Powder camera,

diffractometry and spectrometry methods covered. **Notes** This course is cross-listed with GEOL 420. Credit at the 600-level requires additional work.

GEOL 625 - Principles of Geochemistry
Credits 3
Fundamental geochemical processes operating within the earth's lithosphere, hydrosphere and atmosphere. Topics include chemical differentiation of the earth, crystal chemistry, mineral stability and phase diagrams, aqueous geochemistry, isotope geochemistry, organic chemistry. **Prerequisites** College level chemistry or geochemistry.

GEOL 629 - Geochemical Thermodynamics and Kinetics
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 630 - Geographic Information Systems (GIS): Theory and Applications
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 633 - Glacial and Periglacial Geology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 634 - Quaternary Geology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 636 - Quaternary Paleoecology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 637 - Paleoclimatology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 640 - Volcanology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 643 - Plate Tectonics
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 644 - Tectonics of Orogenic Belts
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 645 - Geophysical Methods
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 645L - Geophysical Methods Lab
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 646 - Geologic Applications in Remote Sensing
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 646L - Geologic Applications in Remote Sensing Lab
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 649 - Geochronology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 671 - Petroleum Geology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 674 - Hydrogeology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 677 - Geology of Metallic Ore Deposits
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 678 - Hydrogeochemistry
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 685 - Engineering Geology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 688 - Microtechniques in Geoscience
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600-level normally requires additional work.

GEOL 701 - Research Methods in Geoscience
Credits 3
Discussion of the processes of scientific research and research design as applied to modern geoscience. Includes scientific approaches to field and laboratory research, research and professional ethics, writing, and public presentation. Model thesis prospectus and grant proposals prepared. **Notes** Required weekend field trips familiarize students with the local geology. **Prerequisites** Graduate standing or consent of instructor.

GEOL 707 - Stable Isotope Geochemistry
Credits 3
Investigates stable isotopes in the hydrologic and geologic cycles, and their use as tracers in paleoclimatology, hydrogeology, and oceanography. Theory and research applications of stable isotopes in geologic, biologic, water, and atmospheric samples, including carbon, oxygen, hydrogen, nitrogen, strontium, and sulfur isotopes. **Prerequisites** Geochemistry.

GEOL 708 - Radiogenic Isotope Geochemistry
Credits 3
Principles of radiogenic isotope geochemistry as a monitor of geochemical processes in the mantle, lithosphere and hydrosphere; applications to petrology, tectonics, economic geology, marine geology and paleoclimatology. **Prerequisites** GEOL 330, GEOL 426, MATH 181 or equivalent, or consent of instructor.

GEOL 709 - Field Methods in Hydrogeology
Credits 3
A survey of techniques used to investigate field problems in hydrogeology. Data collection, analysis, and professional presentation of results are emphasized. Topics may include: water balance measures, water table mapping, estimation of hydraulic parameters, and ground-water monitoring. Additional topics suggested by students may also be explored.

GEOL 710 - Igneous Petrology
Credits 4
Origin of igneous rocks, relation of magma types to tectonic settings, physical properties of magmas, application of trace elements and isotopes to petrogenesis, modeling of crystal fractionation and partial melting, phase diagrams. **Notes** Six hours laboratory. **Prerequisites** GEOL 325 or equivalent or consent of instructor.

GEOL 711 - Principles of Hydrology and Hydraulics
Credits 3
Consideration of modern concepts of hydrology and hydraulics. Includes coverage of statistical methods of analysis, unsteady flow, channel design, modeling and simulation, urban hydrology, and design of hydraulic structures. **Prerequisites** Consent of instructor.

GEOL 712 - Watershed Hydrology
Credits 3
Concepts and processes controlling water movement and distribution within the watershed; analysis techniques for understanding watershed dynamics; numerical simulation of various watershed-scale hydrologic processes. **Prerequisites** Consent of instructor.

GEOL 713 - Flow and Transport in Unsaturated Fractured Media
Credits 3
Explores the current state of understanding regarding fluid flow and contaminant transport in unsaturated fractured geologic media (e.g., rock, soil) through review of recent literature. Competing conceptual models are contrasted in light of existing capabilities for numerical simulation at the scale of pertinent applied problems.

GEOL 715 - Advanced Hydrogeology
Credits 4
Advanced concepts used in ground water investigations, including flow system analysis, resource evaluation, exploration, development, and monitoring. **Prerequisites** GEOL 674

GEOL 716 - Geostatistics
Credits 3
Analysis of the spatial and temporal variations in geologic, hydrologic and geochemical data, including derived distributions, time series analysis, correlation and spectral analysis, interpolation techniques, cluster analysis and sensitivity and uncertainty techniques. **Prerequisites** STA 491 or 691 (or equivalent) or consent of instructor.

GEOL 719 - Vadose Zone Hydrology
Credits 3
Basic physical properties of soils and water and the physical principles governing the soil-water system. Modeling the transport of moisture and chemicals in unsaturated soil with applications to practical field problems. **Prerequisites** GEOL 674

GEOL 720 - Advanced Geochemistry
Credits 4
Contemporary geochemistry applied to igneous, metamorphic, and sedimentary rocks, economic mineral deposits, and problems of the origin of the Earth and other terrestrial planets. **Notes** Six hours laboratory. **Prerequisites** Graduate standing or consent of instructor.

GEOL 725 - Seminar in Petrology
Credits 3
Analysis of current problems, concepts, and research in petrology and closely related fields. **Prerequisites** Graduate standing or consent of instructor.

GEOL 727 - Metamorphic Petrology
Credits 4
Application of field studies, petrography, mineralogy, phase equilibria, and isotopic methods to the study of metamorphic rocks and crustal evolution; explores relationships among metamorphism, tectonics and thermal evolution of the crust. **Notes** Three hours lecture, three hours laboratory. **Prerequisites** GEOL 429/629 or equivalent and graduate standing, or consent of instructor.

GEOL 730 - Seminar in Quaternary Studies

Credits 3
Evaluation of current methodology focused on solving problems of Quaternary chronology, geomorphic processes, and environmental reconstruction. Emphasis on pluvial and post-pluvial environments of the western United States, the evolution of landforms and the development of stratigraphic units and surficial geology originating during the past three million years. **Prerequisites** Graduate standing or consent of instructor.

GEOL 735 - Seminar in Environmental Geology
Credits 3
Application of basic geologic concepts to environmental problems: emphasis on geologic hazards, waste disposal, urban planning, resource policy issues, and environmental programs. **Prerequisites** GEOL 672 or equivalent or consent of instructor.

GEOL 740 - Arid Zone Soils
Credits 3
The role soils have in the soil-plant-atmospheric continuum of arid regions, influence of arid zone soils on all aspects of plant growth and development, influence of soil forming factors on the development of arid soils. **Same as** (BIO 745). **Prerequisites** Consent of instructor.

GEOL 742 - Seminar in Volcanology
Credits 3
Analysis of current problems, concepts, and research in volcanology and closely related fields. **Prerequisites** Graduate standing or consent of instructor.

GEOL 743 - Seminar in Planetary Geology
Credits 3
Analysis of current problems, concepts, and research in planetary geology with emphasis on newly available data. **Prerequisites** Graduate standing or consent of instructor.

GEOL 744 - Tectonics and Structures
Credits 3
Analysis of upper crustal deformation with emphasis on faulting, neotectonics and seismic interpretation; includes a group research project with field and literature data collection, analysis and results suitable for presentation at a professional conference. **Prerequisites** Consent of instructor.

GEOL 745 - Advanced Structural Geology
Credits 3
Analysis of deformation of the Earth's crust with emphasis on deformation mechanisms operative in rocks at different crustal levels; the geometry, kinematics, and dynamics of common geological structural associations, and mechanism and styles of deformation in orogenic belts. **Notes** Three hours lecture per week. **Prerequisites** GEOL 341 and GEOL 349.

GEOL 746 - Strain and Microstructural Analysis
Credits 4
Examination of the principles and techniques of finite and incremental strain analysis and their application to naturally deformed rocks. Investigation of plastic deformation processes and deformation mechanisms, and recognition and interpretation of microstructures developed during deformation. **Notes** Three hours lecture, three hours laboratory. **Prerequisites** GEOL 341 or consent of instructor.

GEOL 747 - Geological Evolution of Western North America

Credits 3
Study of the geological evolution of western North America. Emphasis on the stratigraphic, structural, and tectonic development of the continent within the framework of plate tectonics. **Notes** Three hours lecture per week. **Prerequisites** GEOL 223, GEOL 341, GEOL 462.

GEOL 749 - Advanced Geochronology and Thermochronology
Credits 3
Detailed discussion of isotopic dating of rocks with application to geologic problems. Diffusion theory and reconstruction of thermal histories of rocks. Includes surface exposure dating using cosmogenic isotopes, study of uranium series disequilibrium, luminescence, electron spin resonance, and 14c dating. **Prerequisites** GEOL 426

GEOL 750 - Seminar in Paleobiology
Credits 3
Fossil record as a tool for understanding evolutionary processes, early history of life, eruptive radiation, mass extinction, macroevolution, and origin of higher taxa. **Prerequisites** Graduate standing in geology or biology or consent of instructor.

GEOL 755 - Seminar in Paleontology
Credits 3
Special topics of current interest in paleontology, with emphasis on Great Basin fossil faunas. **Prerequisites** Graduate standing in geology or biology or consent of instructor.

GEOL 760 - Advanced Spatial Modeling with GIS
Credits 4
Advanced study in computer-based techniques for storage, retrieval, analysis, and representation of spatially referenced data. Emphasis on development of spatially distributed models in the geosciences using Geographic Information System (GIS) technology. Students required to develop system models in their chosen thesis area. **Notes** Three hours lecture and three hours lab. **Prerequisites** GEOL 430 or GEOL 630.

GEOL 762 - Geological Applications of Computers
Credits 3
Use of computer algorithms to solve geological problems, geostatistics, modeling of geological processes. **Prerequisites** Graduate standing and CS 116 and 169.

GEOL 765 - Seminar in Stratigraphy
Credits 3
Special topics in stratigraphy with emphasis on southern Nevada and adjacent regions. **Prerequisites** Graduate standing or consent of instructor.

GEOL 766 - Earth Systems Change
Credits 3
Investigate long-term and short-term global climate changes, ocean redox evolution, and their impacts on biospheric innovations. Explore interactions between Earth's sub spheres (lithosphere, hydrosphere, atmosphere, and biosphere) during times of extreme environmental changes in Earth history and testing methods and techniques for such interactions. **Prerequisites** Graduate standing or consent of instructor.

GEOL 770 - Sedimentary Basins
Credits 3
Analysis of current ideas concerning the plate tectonic setting and evolution of sedimentary basins. Emphasis on

characteristic styles of basin sedimentation and resulting stratigraphic framework, provenance of basin fill, chronologic relationship of tectonic events and sedimentation, and methods of basin analysis. **Prerequisites** Graduate standing or consent of instructor.

GEOL 772 - Reflection Seismic Data Interpretation
Credits 4
Fundamentals of geologic interpretation using seismic reflection data. Introduction to seismic data acquisition and processing. Interpretation techniques include well log to seismicities, contour maps and time-to depth conversion. Interpretation of data from different structural settings, seismic stratigraphy, and 3-D seismic interpretation. **Notes** Three hour lecture and three hour lab. **Prerequisites** Graduate standing or consent of instructor.

GEOL 772L - Reflection Seismic Data Interpretation Laboratory
Credits 0
Lab course designed to supplement the lecture course. Interpretations of several structural regimes, structure contour maps, correlation using well logs, creation of synthetics, and the interpretation of a 3-D seismic data set. **Prerequisites** Graduate standing or consent of instructor.

GEOL 773 - Seminar in Geophysics
Credits 1–3
Specialized topics in geophysics with an emphasis on current analysis techniques and problems. **Prerequisites** Graduate standing or consent of instructor.

GEOL 775 - Seminar in Economic Geology
Credits 3
Analysis of current problems, concepts and research in economic geology and closely related fields. **Prerequisites** GEOL 677 or equivalent or consent of instructor.

GEOL 776 - Paleosols Records of Past Landscapes
Credits 3
Recognition and analysis of soil horizons preserved in the rock record. Use of paleosols for reconstructing paleoclimates, tectonics, depositional environments, and other aspects of geologic history. **Prerequisites** Graduate standing and GEOL 462 (or equivalent) or consent of instructor.

GEOL 777 - Instrumental Techniques in Geology
Credits 3
Use of modern instrumentation to acquire geological and geochemical data. Includes, but not limited to, the practical application of x-ray diffraction and fluorescence and atomic absorption spectrophotometry. **Notes** Six hours laboratory. **Prerequisites** Graduate standing or consent of instructor.

GEOL 779 - Theory of Ore Deposition
Credits 3
Study of physical and chemical processes which contribute to metal solubility, transport, and precipitation. Includes fundamental geochemical and thermodynamic concepts as they apply to ore and gangue mineral stability under various geologic conditions. **Prerequisites** GEOL 426 and GEOL 477.

GEOL 780 - Terrigenous Depositional Systems
Credits 3
Examination of modern nonmarine and marine depositional environments dominated by terrigenous sediments, processes that operate in these settings, and responses of sediment to processes. Establish criteria for recognizing

these environments and processes in ancient terrigenous sequences. **Prerequisites** Graduate standing and GEOL 462 or consent of instructor.

GEOL 781 - Carbonate Depositional Systems
Credits 3
Examination of modern non-marine and marine depositional environments dominated by carbonate sediments, organisms that produce sediments, processes that operate in these settings, and responses of sediment to the processes. Establish criteria for recognizing these environments and processes in ancient carbonate sequences. **Prerequisites** Graduate standing and GEOL 462 or consent of instructor.

GEOL 782 - Sandstone Petrology
Credits 4
Description, classification, and interpretation of terrigenous sedimentary rocks. Emphasis on petrographic methods applied to sandstones and interpretation of provenance of sedimentary sequences. **Prerequisites** GEOL 780 (corequisite) or consent of instructor.

GEOL 783 - Carbonate Petrology
Credits 4
Study of the physical and chemical factors important in the genesis and diagenesis of carbonate sediments and rocks. Various analytical techniques covered, with emphasis on thin section petrography for deciphering rock components and diagenesis. **Prerequisites** GEOL 781 (corequisite) or consent of instructor.

GEOL 785 - Seminar in Sedimentology
Credits 1–4
Analysis of current problems, concepts, and research in sedimentary geology and related fields. Emphasis may be upon the genesis and diagenesis of specific sedimentary sequences or upon particular depositional or diagenetic environments. **Prerequisites** Graduate standing and either GEOL 780 or GEOL 781, or consent of instructor.

GEOL 786 - Soils Applications: Paleoclimate, Neotectonics, Archeology
Credits 3
Special topics of current interest in soil science with emphasis on the use of soils for applications in geomorphology, paleoclimate, neotectonics, and/or archeology. **Prerequisites** Graduate standing in geology, biology, anthropology, or consent of instructor.

GEOL 787 - Thesis Research
Credits 1–6
Supervised research prior to approval of master's program prospectus. **Notes** May be repeated to a maximum of six credits, but only one credit can be applied to the student's program. **Grading** S/F grading only. **Prerequisites** Enrollment in the M.S. Program.

GEOL 789 - Dissertation Research
Credits 1–6
Supervised research prior to advancement to candidacy in the doctoral program. **Notes** May be repeated, but only two credits can be applied to the student's program. **Grading** S/F grading only. **Prerequisites** Enrollment in the doctoral program.

GEOL 792 - Seminar in Hydroscience
Credits 1–3
Specialized topics in hydroscience.

GEOL 793 - Independent Study and Research
Credits 1–3
Independent study and research projects in some field of geology. Proposed project for study must be submitted in writing to the graduate program coordinator and the department chair for approval and credit evaluation at least two weeks prior to registration. **Notes** May be repeated for credit, but only three credits are permitted per instructor unless special permission is received. **Prerequisites** Consent of instructor.

GEOL 794 - Directed Readings
Credits 1–3
Supervised readings on special topics in consultation with a geoscience graduate faculty member. **Notes** May be repeated to a maximum of six credits. Requires consent of student's academic adviser. **Grading** S/F grading only. **Prerequisites** Admission to Geoscience Ph.D. program; Consent of instructor.

GEOL 795 - Poster Presentation and Time Management
Credits 1
Presentation of geological information in poster format and time management skills. Poster presentation includes layout and design, focus, data versus interpretation, computer graphics, verbal presentation and referencing. Time management issues include scheduling, planning, organization, and productivity. **Notes** Should be taken during first or second semester of graduate program. **Prerequisites** Graduate standing in Geoscience.

GEOL 796 - Advanced Topics in Geoscience
Credits 1–3
Variety of advanced studies of current and/or topical interest in specialized areas of geoscience. **Notes** May be repeated to a maximum of six credits. **Prerequisites** Varies, depending upon the specific topic.

GEOL 797 - Thesis
Credits 1–6. **Notes** May be repeated, but only six credits applied to the student's program. **Grading** S/F grading only. **Prerequisites** Graduate standing and consent of instructor.

GEOL 799 - Dissertation
Credits 3–6
Research analysis and writing toward completion of dissertation and subsequent defense. **Notes** Twelve credits are required for the degree, may be repeated, but only twelve credits will be applied to the student's degree program. May be repeated but only a maximum of 12 credits may be used in students degree program. **Grading** S/F grade. **Prerequisites** Successful completion of qualifying examination and approval by department.

Life Sciences

The School of Life Sciences (SoLS) offers programs of studies leading to the Master of Science and Doctor of Philosophy degrees. Each degree requires a research thesis (M.S.) or dissertation (Ph.D.). Research leading to the M.S. and Ph.D. degrees may be conducted in one or more of the following fields: cellular and molecular biology; genetics; microbiology; bioinformatics; physiology; population, community, and ecosystem ecology; evolutionary biology; systematics; and biogeography. The School has well-equipped laboratories to support faculty and graduate student research. These facilities are enhanced through access to a number of specialized scientific resources, including the Nevada Genomics Center (which house state-of-the-art equipment that includes an RTPCR machine, an Amersham Typhoon imager, a microarray printer, hybridization capacity and scanner, and a DNA capillary sequencer); the UNLV Confocal and Biological Imaging Core (which houses a NIkon A1R confocal laser scanning miscrocope system); the Ecophysiological Research facility (which includes a greenhouse designed to support experiments at elevated levels of carbon dioxide); an AAALAC-accredited animal care facility; and regional natural history collections, including those of the Wesley E. Niles Herbarium and the Marjorie Barrick Museum. Investigators from the Nevada System of Higher Education's Desert Research Institute also participate in our graduate program. Numerous funding opportunities are available through state-funded graduate assistant programs via statewide initiatives or in association with individual faculty research programs. Prospective students should make contact with one or more faculty members to familiarize themselves with their current research interests, opportunities for conducting research projects, and funding availability. A list of faculty research interests and admission materials are available on-line at the School's web site.

For details regarding application deadlines and the application review process, see the School of Life Sciences' *Graduate Student Handbook*, which is available at http://sols.unlv.edu/gradhandbook.html.

Dennis Bazylinski, Ph.D., Director
Martin R. Schiller, Ph.D.,Graduate Coordinator

Director

Bazylinski, Dennis A. - *Full Graduate Faculty*
Professor; Ph.D., University of New Hampshire, Durham. *Rebel since 2006.*

Graduate Coordinator

Schiller, Martin - *Full Graduate Faculty*
Professor; Ph.D., Utah State University. *Rebel Since 2009.*

Graduate Faculty

Andres, Andrew J. - *Full Graduate Faculty*
Associate Professor; Ph.D., Indiana University, Bloomington. *Rebel since 2002.*

Caberoy, Nora B. - *Full Graduate Faculty*
Assistant Professor; B.S., University of the Philippines, Los Banos; M.S., University of the Philippines, Visayas; Ph.D., Washington State University. *Rebel since 2012.*

Devitt, Dale A. - *Full Graduate Faculty*
Professor; Ph.D., University of California, Riverside. *Rebel since 2005.*

Elekonich, Michelle M. - *Full Graduate Faculty*
Associate Professor; Ph.D., University of Washington, Seattle. *Rebel since 2003.*

Gibbs, Allen G. - *Full Graduate Faculty*
Professor; University of California, San Diego. *Rebel since 2005.*

Hedlund, Brian P. - *Full Graduate Faculty*
Associate Professor; Ph.D., University of Washington, Seattle. *Rebel since 2003.*

Lee, David V. - *Full Graduate Faculty*
Assistant Professor; Ph.D., University of Utah. *Rebel since 2007.*

Raftery, Laurel - *Full Graduate Faculty*
Associate Professor; A.B., University of California, Berkely; Ph.D., University of Colorado, Boulder. *Rebel since 2010*

Reiber, Carl L. - *Full Graduate Faculty*
Professor; Ph.D., University of Massachusetts, Amherst. *Rebel since 1993.*

Riddle, Brett R. - *Full Graduate Faculty*
Professor; Ph.D., University of New Mexico, Albuquerque. *Rebel since 1990.*

Robleto, Eduardo A. - *Full Graduate Faculty*
Associate Professor; Ph.D., University of Wisconsin, Madison. *Rebel since 200*
2.
Rodríguez-Robles, Javier A. - *Full Graduate Faculty*
Associate Professor; University of California, Berkeley. *Rebel since 2002.*

Schulte, Paul J. - *Full Graduate Faculty*
Associate Professor; Ph.D., University of Washington, Seattle. *Rebel since 1990.*

Shen, Jeffery Q. - *Full Graduate Faculty*
Full Professor; Ph.D., Washington University, St. Louis. *Rebel since 2000.*

Smith, Stanley D. - *Full Graduate Faculty*
Professor; Ph.D., Arizona State University, Tempe. *Rebel since 1985.*

Stark, Lloyd R. - *Full Graduate Faculty*
Associate Professor; Ph.D., Pennsylvania State University, University Park. *Rebel since 1999*
.
Starkweather, Peter L. - *Full Graduate Faculty*
Professor; Dartmouth College, Hanover, New Hampshire. *Rebel since 1978.*

Thompson, Daniel B. - *Full Graduate Faculty*
Associate Professor; Ph.D., University of Arizona, Tucson. *Rebel since 1990.*

Tseng, Ai-Sun - *Full Graduate Faculty*
Assistant Professor; Ph.D. *Rebel since 2012.*

Tsourkas, Philippos - *Full Graduate Faculty*
Assistant Professor; Ph.D. *Rebel since 2012. >*
Van Breukelen, Frank - *Full Graduate Faculty*
Associate Professor; Ph.D., University of Colorado, Boulder. *Rebel since 1990.*

Walker, Lawrence R. - *Full Graduate Faculty*
Professor; Ph.D., University of Alaska, Fairbanks. *Rebel since 1992.*

Wing, Helen J. - *Full Graduate Faculty*

Associate Professor; Ph.D., University of Birmingham, Edgbaston, United Kingdom. *Rebel since 2005.*

Professors Emeriti

Babero, Bert B.
Emeritus Professor; Ph.D., University of Illinois. *UNLV Emeritus 1965-1987.*

Deacon, James E.
Emeritus Distinguished Professor; Ph.D., University of Kansas, Lawrence. *UNLV Emeritus 1960-2002.*

Murvosh, Chad M.
Emeritus Professor; Ph.D., Ohio State University, Columbus. *UNLV Emeritus 1964-1992.*

Niles, Wesley E.
Emeritus Professor; Ph.D., University of Arizona, Tucson. *UNLV Emeritus 1968-2002.*

Yousef, Mohamed K.
Emeritus Distinguished Professor; Ph.D., University of Missouri. *UNLV Emeritus 1968-1994*.

School of Life Sciences Courses

BIOL 604 - Principles of Neurobiology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 607 - Molecular Biology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 609 - Virology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 611 - Molecular Evolution
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 618 - Microbial Ecology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 622 - Taxonomy of Vascular Plants
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires

additional work.

BIOL 625 - Genomics
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 626 - Plant Anatomy
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 631 - Ichthyology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 632 - Herpetology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 633 - Ornithology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 634 - Mammalogy
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 638 - Soil Plant Water Relations in Arid Environments
Credits 3
The class will cover soil plant water relationships relevant to arid environments under limited water resources. Topics that will be discussed in detail include; the hydrologic cycle, water properties, soil physical and chemical properites, environmental demand, plant stress associated with drought and salinity, water quality and irrigation management as it relates to plant growth and productivity. The class will be taught in a lecture/lab format. **Prerequisites** CHEM 121, CHEM 122, and BIOL 197 or equivalents.

BIOL 641 - Field Ecology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 642 - Principles of Plant Physiology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 644 - Principles of Plant Ecology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 645 - Cell Physiology
Credits 3
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Same as** BIOL 445. **Notes** Credit at the 600 level normally requires additional work. **Prerequisites** Consent of instructor.

BIOL 647 - Comparative Animal Physiology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 648 - Endocrinology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 651 - Comparative Vertebrate Anatomy Laboratory
Credits 2
The companion laboratory course of BIOL 655. Hands-on dissection of specimens representing major vertebrate groups. Numerous demonstration specimens sample the diversity of fishes, amphibians, and amniotes. Review of fossil vertebrates with emphasis on phylogenetic relationships. **Prerequisites** Biology degree or consent of instructor. **Corequisite** BIOL 655

BIOL 653 - Immunology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 655 - Comparative Vertebrate Anatomy and Biomechanics
Credits 3
Examines structure-function relationships in the context of vertebrate evolution. Tissues and structures of the integumentary, skeletal, and muscular system are emphasized. Biomechanics of materials, structures, and movements are related to adaptations of vertebrates to life in their physical worlds. **Prerequisites** Biology degree or consent of instructor. **Corequisite** BIOL 651

BIOL 660 - Microbial Physiology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 664 - Bacterial Pathogenesis
Credits 3
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found

in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work. **Prerequisites** BIOL 351 or equivalent microbiology class.

BIOL 665 - Vertebrate Embryology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 668 - Histology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 670 - Topics in Applied Microbiology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 671 - Aquatic Ecology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 672 - Limnology
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 680 - Introduction to Biological Modeling
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 685 - Microbial Genetics
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 687 - Principles of Systematics
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 689 - Developmental Genetics
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 690 - Biogeography

Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

BIOL 701 - Ethics in Scientific Research
Credits 1
Examination of ethical problems in scientific research, including the falsification and manipulation of data, public access and peer review, and decisions concerning research problems and support. **Prerequisites** Graduate standing.

BIOL 703 - Biochemical Genetics
Credits 3
Detailed study of the structure of nucleic acids and the molecular genetic mechanisms of replication, transcription, and induction and repression of genetic information. Biochemical genetics of gene transfer. **Prerequisites** BIO 300 and CHEM 471.

BIOL 705 - Secondary Education: Teaching Evolution and the Nature of Science
Credits 1–3
Focus on Science and Creationism and hands-on activities and inquiry-based computer simulations that can be used in classrooms to illustrate evolutionary principles. Workshop taught using scientific methods so educators are well-versed in methods of evolutionary study and principles. **Notes** Follow up sessions explore implementations of lessons from workshop.

BIOL 711 - Advanced Eukaryotic Genetics
Credits 3
Focuses on the biology and genetics of common model organisms: C. elegans, Drosophila, Arabidopsis, Zebrafish, and mouse, and their relationship to the biology of human health and agriculture. The goal is help students understand current research topics in functional genetics and genome manipulation. **Prerequisites** Consent of instructor.

BIOL 714 - Population Genetics
Credits 3
Examines the interactions of evolutionary processes, such as natural selection, genetic drift, gene flow, and mutation, and effects of these interactions on population differentiation, speciation, and extinction. Theoretical and empirical approaches to the study of DNA substitutions and quantitative genetic change addressed. **Prerequisites** MATH 181 and BIO 310 or consent of instructor.

BIOL 722 - Advanced Taxonomy of Vascular Plants
Credits 3
Identification, classification, and evolutionary relationships of the subfamilies and tribes of the composite, legume, and grass families. **Notes** Three hours laboratory. **Prerequisites** BIO 422

BIOL 730A-D - Special Lectures in Life Sciences
Credits 3
Reserved for formal didactic classes with varying special current topics in different disciplines of life sciences. Lettering system reflects focus on topics specific for each Section within Life Sciences (A = Ecology and Evolution, B = Organismal Physiology, C = Cell and Molecular Biology, D = Microbology). **Notes** May be repeated to a maximum of nine credits. **Prerequisites** Consent of instructor.

BIOL 742 - Topics in Advanced Plant Physiology

Credits 2
Advanced treatment of current topics in plant physiology. Topics for consideration selected from one of the three following major subject areas: (a) Water relations, ion balance, and mineral nutrition; (b) Photosynthesis, intermediary metabolism, and plant growth; and (c) Stress physiology. Instructor and students decide which area covered during a given semester. **Notes** May be repeated to a maximum of six credits. **Prerequisites** BIO 442

BIOL 743 - Ecological Plant Physiology
Credits 3
Examination of the physiological responses and adaptations of terrestrial plants to their environment. Primary topics covered include microclimate analysis, water relations, gas exchange, nutrient relations, and adaptations to stress. Adaptations of plants from contrasting physical environments emphasized. **Prerequisites** BIO 340 and BIO 442.

BIOL 745 - Arid Zone Soils
Credits 3
Role soils have in the soil-plant-atmospheric continuum of arid regions, influence of arid zone soils on all aspects of plant growth and development, influence of soil forming factors on the development of arid soils. **Same as** GEOL 740 . **Prerequisites** Consent of instructor.

BIOL 748 - Environmental Physiology
Credits 3
Examination of physiological responses, including adaptation and acclimatization to extreme physical environments. Consideration of desert, tropical, arctic, mountain, and aquatic environments and their physiology, ecological, and phylogenetic implications.

BIOL 763 - Vertebrate Reproductive Biology
Credits 3
Study of vertebrate reproduction at the systematic, organismal and population levels. Individual or group projects. **Prerequisites** BIOL 350, 448 or 465, and consent of instructor.

BIOL 781 - Population and Evolutionary Ecology
Credits 3
Advanced topics in population growth, population interaction and evolution in ecological systems. Includes reading and class discussion of both theoretical and empirical material with emphasis on individual student analysis and integration. **Notes** Three hours of lecture and discussion. **Prerequisites** BIO 340 or equivalent and consent of instructor.

BIOL 783 - Community and Ecosystem Ecology
Credits 3
Readings and evaluation of the highest levels of organization in ecology through: a) exploration of the fundamental concepts of community distributions, structure, organization, and change; and b) analysis of ecosystem-level processes of primary and secondary production and nutrient cycling. **Prerequisites** BIO 340 or equivalent and consent of instructor.

BIOL 784 - Conservation Biology
Credits 3
Science of scarcity and diversity viewed from the perspective of understanding the causes and consequences of extinction as well as the conditions necessary for maintenance of biotic diversity. Review regional and worldwide developments in this emerging subdiscipline. **Prerequisites** BIO 340 or consent of instructor.

BIOL 786 - Bioenergetics
Credits 3
Review of primary and secondary productivity and associated topics dealing with ecosystem energetics. **Notes** Four hours laboratory. **Prerequisites** Consent of instructor.

BIOL 787 - Research Laboratory Rotation
Credits 1–3
Provides an opportunity for newly admitted graduate students to experience the research of Biological Sciences graduate faculty through one-on-one interactions. Gives graduate students the information they need to make informal choices about the lab(s) where they carry out their thesis and dissertation research. **Notes** May be repeated to a maximum of three credits. **Grading** S/F grading only. **Prerequisites** Admission as a regular graduate student in the M.S. or Ph.D. Program.

BIOL 789 - Independent Graduate Study in Life Sciences
Credits 1–3
Students use this class to receive research credit related to their thesis or dissertation project prior to registering for BIOL 797 or BIOL 799. **Notes** May be repeated to a maximum of nine credits. **Prerequisites** Consent of instructor.

BIOL 790A-D - Research Colloquium in Life Sciences
Credits 1–3
Students use this class to present their individual research results to a section-wide audience. Lettering system reflects focus on topics specific for each Section within Life Sciences (A = Ecology and Evolution, B = Organismal Physiology, C = Cell and Molecular Biology, D = Microbiology). **Notes** May be repeated to a maximum of nine credits. **Prerequisites** Consent of instructor.

BIOL 791 - Research Laboratory Discussions in Life Sciences
Credits 1–2
Students present their research and discuss the work of colleagues during formal laboratory meetings with their mentor's research group. **Notes** May be repeated to a maximum of ten credits. **Prerequisites** Consent of instructor.

BIOL 792 - Advanced Topics in Cell and Molecular Biology
Credits 1–3
Includes papers, oral presentations and discussion of current literature in these fields. **Notes** Topics announced with each offering. May be repeated to a maximum of twelve credits. **Prerequisites** Graduate standing and consent of instructor.

BIOL 793A-D - Advanced Topics in Life Sciences
Credits 1–2
A seminar-style class where presentations are organized around a common theme. Students present and discuss the related primary literature. Lettering system reflects focus on topics specific for each Section within Life Sciences (A = Ecology and Evolution, B = Organismal Physiology, C = Cell and Molecular Biology, D = Microbiology. **Notes** May be repeated to a maximum of six credits. **Prerequisites** Consent of instructor.

BIOL 794 - Techniques in Molecular Biology
Credits 3
Introduction to the theory and laboratory methods used in molecular biology research. Topics include the isolation and purification of nucleic acids, restriction digests, cloning. Southern blotting, PCR, DNA sequencing, and electrophoresis. **Notes** Three to nine laboratory hours per week. **Prerequisites** Consent of instructor.

BIOL 795 - Teaching Strategies for University Science Courses
Credits 2
Designed for graduate students in the sciences and will prepare you for University-level science teaching, whether pursuing a research-based or teaching-based faculty position. We explore different learning theories, current research about learning science and applying them to teaching and the development of a personal teaching philosophy.

BIOL 796 A-D - Graduate Seminar
Credits 1–2
Instructs students on how to prepare and present seminars on topics of current interest in life sciences. Lettering system reflects focus on topics specific for each Section within Life Sciences (A = Ecology and Evolution, B = Organismal Physiology, C = Cell and Molecular Biology, D = Microbiology). **Notes** May be repeated to a maximum of ten credits. **Prerequisites** Graduate standing in biology.

BIOL 797 - Thesis
Credits 3–6. **Notes** May be repeated but only six credits applied to the student's program. Enrollment by consent of instructor only. **Grading** S/F grading only.

BIOL 799 - Dissertation
Credits 3–6
Research analysis and writing toward completion of dissertation and subsequent defense. **Notes** May be repeated but a maximum of only 18 credits may be applied to the degree program. **Grading** S/F grading only. **Prerequisites** Graduate standing in the Biology Ph.D. program and consent of instructor.

Mathematical Sciences

The Department of Mathematical Sciences offers both the Master of Science and Doctor of Philosophy degrees. The M.S. program has areas of concentration in Pure Mathematics, Applied Mathematics, Applied Statistics, Statistics, and Teaching Mathematics. The Ph.D. program has areas of concentration in Applied Mathematics, Computational Mathematics, Pure Mathematics, and Statistics. Specific disciplines include approximation theory, applied complex analysis, bioinformatics, biostatistics, calculus of variations, combinatorics, control theory, finite fields, graph theory, mathematical education, mathematical modeling, number theory, numerical analysis, partial differential equations, scientific computing, set theory, statistics. Excellent computing facilities are available for classroom studies and research. The Department of Mathematical Sciences, through an active faculty, offers graduate students both an unusual amount of personal attention and a lively research atmosphere. The degree programs are designed to provide students with a strong theoretical background in graduate-level mathematics. Our graduates have been successful in finding employment in industry, government and education.

Derrick DuBose, Ph.D., Chair
Douglas Burke, Ph.D., Graduate Coordinator

Chair

DuBose, Derrick A. - *Full Graduate Faculty*
Associate Professor; B.A., California State University, Long Beach; M.A., Ph.D., University of California, Los Angeles. *Rebel since 1987.*

Graduate Coordinator

Burke, Douglas - *Full Graduate Faculty*
Associate Professor; B.S., University of Wisconsin, Madison; M.A., University of California, Berkeley; Ph.D., University of California, Los Angeles. *Rebel since 1994.*

Graduate Faculty

Amei, Amei - *Full Graduate Faculty*
Assistant Professor; B.S., Inner Mongolia University; M.S., University of Science and Technology of China; Ph.D., Washington University. *Rebel since 2007.*

Ananda, Malwane M.A. - *Full Graduate Faculty*
Professor; B.S., University of Sri Jayewardenepura; M.S., Ph.D., Purdue University. *Rebel since 1990.*

Bachman, Gennady - *Full Graduate Faculty*
Professor; B.A., Temple University; Ph.D., University of Illinois. *Rebel since 1991.*

Baragar, Arthur - *Full Graduate Faculty*
Associate Professor; B.S., University of Alberta; Ph.D., Brown University. *Rebel since 1997.*

Bellomo, Carryn - *Full Graduate Faculty*
Associate Professor; B.S., M.S., Ph.D., Old Dominion University. *Rebel since 2003.*

Bhatnagar, Satish C. - *Full Graduate Faculty*
Professor; B.A. (honor), M.A., Panjab University, India; M.A., Ph.D. Indiana University. *Rebel since 1974.*

Catlin, Sandra - *Full Graduate Faculty*

Associate Professor; B.A., University of California, Berkeley; M.S., Ph.D., University of Washington. *Rebel since 1997.*

Cho, Hokwon - *Full Graduate Faculty*
Associate Professor; B.A., Korea University; M.A., Ph.D., University of California, Santa Barbara. *Rebel since 1999.*

Costa, David - *Full Graduate Faculty*
Professor; B.S., Federal University of Pernambuco, Recife, Brazil; Ph.D., Brown University. *Rebel since 1993.*

Dalpatadu, Rohan - *Full Graduate Faculty*
Associate Professor; B.S., University of Ceylon; M.S., Ph.D., Southern Illinois University at Carbondale. *Rebel since 1985.*

Ding, Zhonghai - *Full Graduate Faculty*
Professor; B.S., Nanjing Institute of Technology; M.S., Institute of Systems Science; Ph.D., Texas A&M University.

Ghosh, Kaushik - *Full Graduate Faculty*
Assistant Professor; B. Stat., Indian Statistical Institute; M.Stat., Indian Statistical Institute; Ph.D., University of California Santa Barbara. *Rebel since 2007.*

Ho, Chih-Hsiang - *Full Graduate Faculty*
Professor; B.S., National Central University; M.S., New Mexico Highlands University; M.S., Ph.D., University of Minnesota. *Rebel since 1986.*

Li, Jichun - *Full Graduate Faculty*
Associate Professor; B.S., M.S., Nanjing University, China; Ph.D., Florida State University. *Rebel since 2000.*

Li, Xin - *Full Graduate Faculty*
Associate Professor; B.S., M.S., Jilin University, Changchun; Ph.D., Texas A&M University. *Rebel since 1992.*

Marcozzi, Michael - *Full Graduate Faculty*
Associate Professor; B.S., M.S., Ph.D., University of Delaware. *Rebel since 1997.*

Muleshkov, Angel - *Full Graduate Faculty*
Associate Professor; M.S., Ph.D., University of Washington. *Rebel since 1989.*

Neda, Monika - *Full Graduate Faculty*
Assistant Professor; B.S., University of Novi Sad; Ph.D., University of Pittsburgh. *Rebel since 2007.*

Phanord, Dieudonne´D. - *Full Graduate Faculty*
Professor; B.S., Gordon College; M.S., Ph.D., University of Illinois, Chicago. *Rebel since 2002.*

Salehi, Ebrahim - *Full Graduate Faculty*
Associate Professor; B.S., University of Tehran; M.S., Institute of Mathematics, Tehran; M.S., Ph.D., University of Washington. *Rebel since 1985.*

Robinette, Michelle - *Full Graduate Faculty*
Associate Professor; B.S., M.A., Ph.D., Western Michigan University. *Rebel since 1996.*

Shiue, Peter - *Full Graduate Faculty*
Professor; B.S., National Taiwan Normal University; M.S., Ph.D., Southern Illinois University. *Rebel since 1985.*

Sun, Pengtao - *Full Graduate Faculty*
Assistant Professor; B.S., M.S., Shandong University; Ph.D. Institute of Mathematics, Academia Sinica. *Rebel since 2007.*

Tehrani, Hossein - *Full Graduate Faculty*
Associate Professor; B.S., Sharif University of Technology; M.S., Ph.D., Courant Institute of Mathematical Sciences. *Rebel since 1997.*

Westveld, Anton H. - *Full Graduate Faculty*
Assistant Professor; B.A., M.A., University of Michigan; Ph.D., University of Washington. *Rebel since 2007.*

Yang, Hongtao - *Full Graduate Faculty*
Assistant Professor; B.S., M.S., Jilin University; Ph.D., University of Alberta. *Rebel since 2007.*

Professors Emeriti

Aizely, Paul
Professor; B.A., Harvard University; M.S., University of Arizona; Ph.D., Arizona State University. *UNLV Emeritus 1968-2008.*

Bowman, Harold
Emeritus Associate Professor; B.E.E., City College of New York; M.A., Oklahoma University; Ph.D., Arizona State University. *UNLV Emeritus 1972-1999.*

Graham, Malcolm
Emeritus Professor; B.S., New Jersey State College; M.S., University of Massachusetts: Ed.D., Columbia University. *UNLV Emeritus 1956-1985.*

Miel, George, J.
Emeritus Professor; B.S., M.S., University of Illinois; Ph.D., University of Wyoming. *UNLV Emeritus 1977-1985 & 1991-2006.*

Nietling, Lloyd
Emeritus Associate Professor; B.A., St. Mary of the Plains College; B.S., Aquinas College; M.A., University of Michigan; Ph.D., Ohio State University. *UNLV Emeritus 1967-1992.*

Master of Science - Mathematical Sciences

Plan Description

The degree is a well-established MS program with concentrations in Applied Math, Pure Math, Statistics, and Math Education to serve students in many different areas of Mathematical Sciences.

The concentrations in pure, applied, and statistics each include a core requirement corresponding to the given area. Additional credits are required so that students can develop knowledge in a field of interest. All three require the student to either defend a thesis or pass a written comprehensive exam corresponding to the core requirements.

The teaching mathematics concentration requires a variety of content courses, as well as, education courses. The degree options for the teaching math concentration include the opportunity to write a professional paper.

Learning Outcomes

www.unlv.edu/degree/ms-mathematical-sciences

Plan Admission Requirements

- All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements.
- Have a bachelor's degree with a minimum GPA of 2.75 for all undergraduate work or a minimum GPA of 3.00 for the last two years of undergraduate work, and completed at least 18 credits of upper-division mathematics or statistics courses beyond calculus.
- Submit application materials to both the Graduate College and the Department of Mathematical Sciences.
- Firstly, applicants must submit to the Graduate College the following materials:
    - A completed online application
    - Submit official transcripts from all post-secondary institutions attended
- Secondly, applicants must submit to the Department of Mathematical Sciences the following materials:
    - Copies of all transcripts sent to the Graduate College
    - At least two letters of recommendation from persons familiar with the applicant's academic record and potential for advanced study in mathematical sciences
    - A statement of purpose describing the aim in applying for graduate study, the particular area of specialization within the mathematical sciences (if known), and any additional information that may aid the selection committee in evaluating the applicant's preparation and aptitude for graduate study
    - A completed online Graduate Assistantship application, if interested

Plan Requirements

See Subplan Requirements below.

Subplan 1 Requirements: Pure Mathematics - Thesis Track

Total Credits Required: 33

Course Requirements

- Analysis Courses – Credits: 6
    - Complete two of the following courses:
        - MAT 707 - Real Analysis I
        - MAT 708 - Real Analysis II
        - MAT 709 - Complex Function Theory I
        - MAT 710 - Complex Function Theory II
        - MAT 771 - Applied Analysis I
        - MAT 772 - Applied Analysis II
        - Algebra Course – Credits: 3
    - Complete one of the following courses:
        - MAT 703 - Abstract Algebra III
        - MAT 704 - Abstract Algebra IV
        - MAT 753 - Homological Algebra
        - MAT 754 - Homological Algebra
        - MAT 755 - Topics in Algebra
- Area of Emphasis Courses – Credits: 6
    - Complete an additional 6 credits of 700-level MAT courses (excluding MAT 711 & 712) in a field of special interest.
- Elective Courses – Credits: 12

    - Complete 12 credits of 600- or 700-level MAT or STA courses (excluding MAT 711 & 712), or other advisor-approved courses.
- Thesis – Credits: 6
    - MAT 791 - Thesis

Degree Requirements

- Students must complete a minimum of 33 credit hours with a minimum GPA of 3.00.
- Of the 33 required credits, 27 must be coursework. Of those 27 coursework credits, at least 18 must be 700-level.
- A student will be placed on academic probation if a minimum of 3.00 GPA is not maintained in all work taken in the degree program. A grade of C or less in one graduate-level course will cause a student to be placed on academic probation and will elicit a critical review of the student's program by the Graduate Studies Committee. Students who fail to meet the conditions of their probation will be separated.
- In consultation with his/her advisor, a student will organize a thesis committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.

Graduation Requirements

- The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
- The student must submit and successfully defend his/her thesis by the posted deadline. The defense must be advertised and is open to the public.
- The student must submit his/her approved, properly formatted hard-copy thesis to the Graduate College, and submit the approved electronic version to ProQuest by the posted deadline.

Subplan 2 Requirements: Pure Mathematics - Comprehensive Exam Track

Total Credits Required: 30

Course Requirements

- Analysis Courses – Credits: 6
    - Complete two of the following courses:
        - MAT 707 - Real Analysis I
        - MAT 708 - Real Analysis II
        - MAT 709 - Complex Function Theory I
        - MAT 710 - Complex Function Theory II
        - MAT 771 - Applied Analysis I
        - MAT 772 - Applied Analysis II
- Algebra Course – Credits: 3
    - Complete one of the following courses:
        - MAT 703 - Abstract Algebra III
        - MAT 704 - Abstract Algebra IV
        - MAT 753 - Homological Algebra
        - MAT 754 - Homological Algebra

        - MAT 755 - Topics in Algebra
- Area of Emphasis Courses – Credits: 6
    - Complete an additional 6 credits of 700-level MAT courses (excluding MAT 711 & 712) in a field of special interest.
- Elective Courses – Credits: 15
    - Complete 15 credits of 600- or 700-level MAT or STA courses (excluding MAT 711 & 712), or other advisor-approved courses.

Degree Requirements

- Students must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
- Of the 30 required credits, at least 18 must be 700-level.
- A student will be placed on academic probation if a minimum of 3.00 GPA is not maintained in all work taken in the degree program. A grade of C or less in one graduate-level course will cause a student to be placed on academic probation and will elicit a critical review of the student's program by the Graduate Studies Committee.
- In consultation with his/her advisor, a student will organize an advisory committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.

Graduation Requirements

- The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
- The student must pass a final comprehensive examination.

Subplan 3 Requirements: Applied Mathematics - Thesis Track

Total Credits Required: 33

Course Requirements

- Required Courses – Credits: 6
    - Complete two of the following courses:
        - MAT 707 - Real Analysis I
        - MAT 708 - Real Analysis II
        - MAT 709 - Complex Function Theory I
        - MAT 710 - Complex Function Theory II
        - MAT 771 - Applied Analysis I
        - MAT 772 - Applied Analysis II
- Numerical Analysis Course – Credits: 3
    - Complete one of the following courses:
        - MAT 663 - Advanced Matrix Theory and Applications
        - MAT 765 - Advanced Numerical Analysis
        - MAT 767 - Topics in Numerical Analysis
- Applied and Computational Courses – Credits: 6
    - Complete 6 credits of 700-level advisor-approved MAT coursework in applied and computational mathematics.

- Elective Courses – Credits: 12
    - Complete 12 credits of 600- or 700-level MAT or STA courses (excluding MAT 711 & 712), or other advisor-approved courses.
- Thesis – Credits: 6
    - MAT 791 - Thesis

Degree Requirements

- Students must complete a minimum of 33 credit hours with a minimum GPA of 3.00.
- Of the 33 required credits, 27 must be coursework. Of those 27 coursework credits, at least 18 must be 700-level.
- A student will be placed on academic probation if a minimum of 3.00 GPA is not maintained in all work taken in the degree program. A grade of C or less in one graduate-level course will cause a student to be placed on academic probation and will elicit a critical review of the student's program by the Graduate Studies Committee.
- In consultation with his/her advisor, a student will organize a thesis committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.

Graduation Requirements

- The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
- The student must submit and successfully defend his/her thesis by the posted deadline. The defense must be advertised and is open to the public.
- The student must submit his/her approved, properly formatted hard-copy thesis to the Graduate College, and submit the approved electronic version to ProQuest by the posted deadline.

Subplan 4 Requirements: Applied Mathematics - Comprehensive Exam Track

Total Credits Required: 30

Course Requirements

- Required Courses – Credits: 6
    - Complete two of the following courses:
        - MAT 707 - Real Analysis I
        - MAT 708 - Real Analysis II
        - MAT 709 - Complex Function Theory I
        - MAT 710 - Complex Function Theory II
        - MAT 771 - Applied Analysis I
        - MAT 772 - Applied Analysis II
- Numerical Analysis Course – Credits: 3
    - Complete one of the following courses:
        - MAT 663 - Advanced Matrix Theory and Applications
        - MAT 765 - Advanced Numerical Analysis
        - MAT 767 - Topics in Numerical Analysis

- Applied and Computational Courses – Credits: 6
    - Complete 6 credits of 700-level advisor-approved MAT coursework in applied and computational mathematics.
- Elective Courses – Credits: 15
    - Complete 15 credits of 600- or 700-level MAT or STA courses (excluding MAT 711 & 712), or other advisor-approved courses.

Degree Requirements

- Students must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
- Of the 30 required credits, at least 18 must be 700-level.
- A student will be placed on academic probation if a minimum of 3.00 GPA is not maintained in all work taken in the degree program. A grade of C or less in one graduate-level course will cause a student to be placed on academic probation and will elicit a critical review of the student's program by the Graduate Studies Committee.
- In consultation with his/her advisor, a student will organize an advisory committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.

Graduation Requirements

- The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
- The student must successfully complete a final comprehensive examination.

Subplan 5 Requirements: Applied Statistics - Thesis Track

Total Credits Required: 33

Course Requirements

- Required Courses – Credits: 6
    - MAT 657 - Introduction to Real Analysis I
    - MAT 663 - Advanced Matrix Theory and Applications
- Core Courses – Credits: 12
    - STA 761 - Regression Analysis I
    - STA 762 - Regression Analysis II
    - STA 767 - Mathematical Statistics I
    - STA 768 - Mathematical Statistics II
- Statistics Courses – Credits: 6
    - Complete an additional 6 credits of 700-level STA coursework in a field of special interest to the student.
- Elective Courses – Credits: 3
    - Complete 3 credits of 600- or 700-level MAT or STA courses (excluding MAT 711 & 712), or other advisor-approved courses.
- Thesis – Credits: 6
    - MAT 791 - Thesis

Degree Requirements

- Students must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
- Of the 33 required credits, 27 must be coursework. Of those 27 coursework credits, at least 18 must be 700-level.
- A student will be placed on academic probation if a minimum of 3.00 GPA is not maintained in all work taken in the degree program. A grade of C or less in one graduate-level course will cause a student to be placed on academic probation and will elicit a critical review of the student's program by the Graduate Studies Committee.
- In consultation with his/her advisor, a student will organize a thesis committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.

Graduation Requirements

- The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
- The student must submit and successfully defend his/her thesis by the posted deadline. The defense must be advertised and is open to the public.
- The student must submit his/her approved, properly formatted hard-copy thesis to the Graduate College, and submit the approved electronic version to ProQuest by the posted deadline.

Subplan 6 Requirements: Applied Statistics - Comprehensive Exam Track

Total Credits Required: 30

Course Requirements

- Required Courses – Credits: 6
  - MAT 657 - Introduction to Real Analysis I
  - MAT 663 - Advanced Matrix Theory and Applications
- Core Courses – Credits: 12
  - STA 761 - Regression Analysis I
  - STA 762 - Regression Analysis II
  - STA 767 - Mathematical Statistics I
  - STA 768 - Mathematical Statistics II
- Statistics Courses – Credits: 6
  - Complete an additional 6 credits of 700-level STA coursework in a field of special interest to the student.
- Elective Courses – Credits: 6
  - Complete 6 credits of 600- or 700-level MAT or STA courses (excluding MAT 711 & 712), or other advisor-approved courses.

Degree Requirements

- Students must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
- Of the 30 required credits, 27 must be coursework. Of those 27 coursework credits, at least 18 must be 700-level.

- A student will be placed on academic probation if a minimum of 3.00 GPA is not maintained in all work taken in the degree program. A grade of C or less in one graduate-level course will cause a student to be placed on academic probation and will elicit a critical review of the student's program by the Graduate Studies Committee.
- In consultation with his/her advisor, a student will organize an advisory committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.

Graduation Requirements

- The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
- The student must pass a final comprehensive examination.

Subplan 7 Requirements: Teaching Mathematics - Professional Paper Track

Total Credits Required: 30

Course Requirements

- Required Courses – Credits: 9
  - MAT 711 - Survey of Mathematical Problems I
  - MAT 712 - Survey of Mathematical Problems II
  - MAT 714 - History of Mathematics
- Algebra Course – Credits: 3
  - Complete one of the following courses:
    - MAT 653 - Abstract Algebra I
    - MAT 654 - Abstract Algebra II
    - MAT 703 - Abstract Algebra III
    - MAT 704 - Abstract Algebra IV
    - MAT 655 - Elementary Theory of Numbers I
    - MAT 669 - Combinatorics I
    - MAT 670 - Combinatorics II
- Analysis Course – Credits: 3
  - Complete one of the following courses:
    - MAT 657 - Introduction to Real Analysis I
    - MAT 658 - Introduction to Real Analysis II
    - MAT 707 - Real Analysis I
    - MAT 708 - Real Analysis II
    - MAT 659 - Elementary Complex Analysis
    - MAT 709 - Complex Function Theory I
    - MAT 710 - Complex Function Theory II
    - MAT 687 - Introduction to Partial Differential Equations
- Foundations Course – Credits: 3
  - Complete one of the following courses:
    - MAT 651 - Foundations of Mathematics I
    - MAT 652 - Foundations of Mathematics II

        - MAT 701 - Foundations of Mathematics III
        - MAT 702 - Foundations of Mathematics IV
        - MAT 680 - College Geometry
        - MAT 683 - General Topology I
        - MAT 684 - General Topology II
- Education Courses – Credits: 6
    - Complete two of the following courses:
        - CIS 622 - Instructional Middle School Mathematics Education
        - CIS 624 - Instruction Secondary Mathematics Education
        - CIG 620 - Principles of Learning Mathematics
- Elective Courses – Credits: 3
    - Complete 3 credits of 600- or 700-level MAT or STA courses, or other advisor-approved courses.
- Professional Paper – Credits: 3
    - MAT 793 - Teaching Concentration Professional Paper Research

Degree Requirements

- Students must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
- Of the 30 required credits, 27 must be coursework. Of those 27 coursework credits, at least 15 must be 700-level.
- A student will be placed on academic probation if a minimum of 3.00 GPA is not maintained in all work taken in the degree program. A grade of C or less in one graduate-level course will cause a student to be placed on academic probation and will elicit a critical review of the student's program by the Graduate Studies Committee.
- In consultation with his/her advisor, a student will organize an advisory committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.

Graduation Requirements

- The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
- The student must successfully complete and defend a professional paper.

Subplan 8 Requirements: Teaching Mathematics - Comprehensive Exam Track

Total Credits Required: 30

Course Requirements

- Required Courses – Credits: 9
    - MAT 711 - Survey of Mathematical Problems I
    - MAT 712 - Survey of Mathematical Problems II
    - MAT 714 - History of Mathematics
- Algebra Course – Credits: 3
    - Complete one of the following courses:
        - MAT 653 - Abstract Algebra I
        - MAT 654 - Abstract Algebra II

        - MAT 703 - Abstract Algebra III
        - MAT 704 - Abstract Algebra IV
        - MAT 655 - Elementary Theory of Numbers I
        - MAT 669 - Combinatorics I
        - MAT 670 - Combinatorics II
- Analysis Course – Credits: 3
    - Complete one of the following courses:
        - MAT 657 - Introduction to Real Analysis I
        - MAT 658 - Introduction to Real Analysis II
        - MAT 707 - Real Analysis I
        - MAT 708 - Real Analysis II
        - MAT 659 - Elementary Complex Analysis
        - MAT 709 - Complex Function Theory I
        - MAT 710 - Complex Function Theory II
        - MAT 687 - Introduction to Partial Differential Equations
- Foundations Course – Credits: 3
    - Complete one of the following courses:
        - MAT 651 - Foundations of Mathematics I
        - MAT 652 - Foundations of Mathematics II
        - MAT 701 - Foundations of Mathematics III
        - MAT 702 - Foundations of Mathematics IV
        - MAT 680 - College Geometry
        - MAT 683 - General Topology I
        - MAT 684 - General Topology II
- Education Courses – Credits: 6
    - Complete two of the following courses:
        - CIS 622 - Instructional Middle School Mathematics Education
        - CIS 624 - Instruction Secondary Mathematics Education
        - CIG 620 - Principles of Learning Mathematics
- Elective Courses – Credits: 6
    - Complete 6 credits of 600- or 700-level MAT or STA courses, or other advisor-approved courses.

Degree Requirements

- Students must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
- Of the 30 required credits, 27 must be coursework. Of those 27 coursework credits, at least 15 must be 700-level.
- A student will be placed on academic probation if a minimum of 3.00 GPA is not maintained in all work taken in the degree program. A grade of C or less in one graduate-level course will cause a student to be placed on academic probation and will elicit a critical review of the student's program by the Graduate Studies Committee.
- In consultation with his/her advisor, a student will organize an advisory committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.

Graduation Requirements

- The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
- The student must pass a final comprehensive examination.

Plan Graduation Requirements

Refer to your subplan for Graduation Requirements.

- Subplan 1: Pure Mathematics – Thesis Track
- Subplan 2: Pure Mathematics – Comprehensive Exam Track
- Subplan 3: Applied Mathematics – Thesis Track
- Subplan 4: Applied Mathematics – Comprehensive Exam Track
- Subplan 5: Applied Statistics – Thesis Track
- Subplan 6: Applied Statistics – Comprehensive Exam Track
- Subplan 7: Teaching Mathematics – Professional Paper Track
- Subplan 8: Teaching Mathematics – Comprehensive Exam Track

Doctor of Philosophy - Mathematical Sciences

Plan Description

UNLV's Mathematical Sciences Ph.D. program is Nevada's only Ph.D. program in the Mathematical Sciences. It is relatively new (established in 2005) and includes concentrations in Applied Math, Pure Math, Computational Math, and Statistics to serve students in many different areas of Mathematical Sciences.

The main part of the Ph.D. is the dissertation. The degree requirements also include: credit requirement, qualifying examination requirement, subject area breadth requirement.

The qualifying examination requirement and the subject area breadth requirement are tailored according to the area of concentration.

Learning Outcomes

www.unlv.edu/degree/phd-mathematical-sciences

Plan Admission Requirements

In addition to the requirements of the Graduate College, applicants must satisfy the admission requirements of the Department of Mathematical Sciences summarized as follows. Applicants seeking direct admission to the doctoral program without a previously earned master's degree must have a minimum GPA of 3.00 for all undergraduate work or a minimum GPA of 3.25 for the last two years of undergraduate mathematics work. Applicants with a master's degree must have a minimum GPA 3.00 for all graduate work and at least 15 credits of graduate course work in Mathematical Sciences with a grade of B or better. Applicants must submit the official score of the GRE General Test with a minimum score in the top 35% on the GRE quantitative.

To apply for admission to the Ph.D. Program, applicants must submit application materials to both the Graduate College and the Department of Mathematical Sciences.

Firstly, applicants must submit to the Graduate College the following materials:

- A completed application form.
- The official transcripts from all colleges and universities the student has attended.

Secondly, applicants must submit to the Department the following materials:

- Copies of all official transcripts sent to the Graduate College.
- At least three letters of recommendation from persons familiar with the applicant's academic record and potential for advanced study in mathematical sciences.
- The official GRE General Test score
- A completed application for Graduate Assistantship, if interested.
- A statement of purpose describing the aim in applying for graduate study, the particular area of specialization within the mathematical sciences (if known), and any additional information that may aid the selection committee in evaluating preparation and aptitude for graduate study.

Details of the admission procedure for the Ph.D. Program can be found on the Department's web site.

All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements.

Plan Requirements

See subplan requirements below.

Subplan 1 Requirements: Post-Bachelor's - Applied Mathematics Track

Total Credits Required: 78

Course Requirements

- Required Courses Part 1– Credits: 6
  - Complete two analysis or two theory courses:
    - MAT 707 - Real Analysis I
    - MAT 708 - Real Analysis II
    - OR
    - MAT 709 - Complex Function Theory I
    - MAT 710 - Complex Function Theory II
- Required Courses Part 2 – Credits: 6
  - MAT 771 - Applied Analysis I
  - MAT 772 - Applied Analysis II
- Subject Area Courses – Credits: 12
  - Complete two of the following one-year course sequences:
    - MAT 703 - Abstract Algebra III
    - MAT 704 - Abstract Algebra IV
    - MAT 723 - Advanced Ordinary Differential Equations I
    - MAT 724 - Advanced Ordinary Differential Equations II
    - MAT 729 - Partial Differential Equations I
    - MAT 730 - Partial Differential Equations II
    - MAT 733 - Topology
    - MAT 734 - Topology

        - MAT 765 - Advanced Numerical Analysis
        - MAT 766 - Advanced Numerical Analysis
        - STA 767 - Mathematical Statistics I
        - STA 768 - Mathematical Statistics II
- Additional Courses – Credits: 12
    - Complete 12 credits of 700-level MAT or STA courses (excluding MAT 711 & 712), or other advisor-approved courses.
- Elective Courses – Credits: 24
    - Complete 24 credits of 600- or 700-level MAT or STA courses (excluding MAT 711 & 712), or other advisor-approved courses.
- Dissertation – Credits: 18
    - MAT 799 - Dissertation

Degree Requirements

See Plan Degree Requirements below.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 2 Requirements: Post-Bachelor's - Computational Mathematics Track

Total Credits Required: 78

Course Requirements

- Required Courses Part 1 – Credits: 6
    - Complete two analysis or two theory courses:
        - MAT 707 - Real Analysis I
        - MAT 708 - Real Analysis II

          OR
        - MAT 709 - Complex Function Theory I
        - MAT 710 - Complex Function Theory II
- Required Courses Part 2 – Credits: 6
    - MAT 765 - Advanced Numerical Analysis
    - MAT 766 - Advanced Numerical Analysis
- Subject Area Courses – Credits: 12
    - Complete two of the following one-year course sequences:
        - MAT 703 - Abstract Algebra III
        - MAT 704 - Abstract Algebra IV
        - MAT 723 - Advanced Ordinary Differential Equations I
        - MAT 724 - Advanced Ordinary Differential Equations II
        - MAT 729 - Partial Differential Equations I
        - MAT 730 - Partial Differential Equations II
        - MAT 733 - Topology
        - MAT 734 - Topology
        - MAT 771 - Applied Analysis I
        - MAT 772 - Applied Analysis II

        - STA 767 - Mathematical Statistics I
        - STA 768 - Mathematical Statistics II
- Additional Courses – Credits: 12
    - Complete 12 credits of 700-level MAT or STA courses (excluding MAT 711 & 712), or other advisor-approved courses.
- Elective Courses – Credits: 24
    - Complete 24 credits of 600- or 700-level MAT or STA courses (excluding MAT 711 & 712), or other advisor-approved courses.
- Dissertation – Credits: 18
    - MAT 799 - Dissertation

Degree Requirements

See Plan Degree Requirements below.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 3 Requirements: Post-Bachelor's - Pure Mathematics Track

Total Credits Required: 78

Course Requirements

- Required Courses Part 1 – Credits: 6
    - Complete two analysis or two theory courses:
        - MAT 707 - Real Analysis I
        - MAT 708 - Real Analysis II

          OR
        - MAT 709 - Complex Function Theory I
        - MAT 710 - Complex Function Theory II
- Required Courses Part 2 – Credits: 6
    - MAT 703 - Abstract Algebra III
    - MAT 704 - Abstract Algebra IV
- Subject Area Courses – Credits: 12
    - Complete two of the following one-year course sequences:
        - MAT 701 - Foundations of Mathematics III
        - MAT 702 - Foundations of Mathematics IV
        - MAT 717 - Analytical Solution Methods for Partial Differential Equations, I
        - MAT 718 - Analytical Solution Methods for Partial Differential Equations, II
        - MAT 723 - Advanced Ordinary Differential Equations I
        - MAT 724 - Advanced Ordinary Differential Equations II
        - MAT 733 - Topology
        - MAT 734 - Topology
        - MAT 771 - Applied Analysis I
        - MAT 772 - Applied Analysis II
        - STA 767 - Mathematical Statistics I
        - STA 768 - Mathematical Statistics II

- Additional Courses – Credits: 12
    - Complete 12 credits of 700-level MAT or STA courses (excluding MAT 711 & 712), or other advisor-approved courses.
- Elective Courses – Credits: 24
    - Complete 24 credits of 600- or 700-level MAT or STA courses (excluding MAT 711 & 712), or other advisor-approved courses.
- Dissertation – Credits: 18
    - MAT 799 - Dissertation

Degree Requirements

See Plan Degree Requirements below.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 4 Requirements: Post-Bachelor's - Statistics Track

Total Credits Required: 78

Course Requirements

- Required Courses Part 1 – Credits: 6
    - STA 767 - Mathematical Statistics I
    - STA 768 - Mathematical Statistics II
- Required Courses Part 2 – Credits: 6
    - STA 761 - Regression Analysis I
    - STA 762 - Regression Analysis II
- Subject Area Courses – Credits: 12
    - Complete two of the following one-year course sequences:
        - STA 713 - Experimental Design
        - STA 715 - Multivariate Statistical Methods
        - STA 750 - Time Series Analysis
        - STA 751 - Spatial Statistics
        - STA 755 - Stochastic Modeling I
        - STA 756 - Stochastic Modeling II
        - STA 753 - Bayesian Data Analysis
        - STA 765 - Statistical Decision Theory
        - STA 763 - Analysis of Variance I
        - STA 764 - Analysis of Variance II
        - MAT 707 - Real Analysis I
        - STA 731 - Probability Theory and Its Applications
- Additional Courses – Credits: 12
    - Complete 12 credits of 700-level MAT or STA courses (excluding MAT 711 & 712), or other advisor-approved courses.
- Elective Courses – Credits: 24

    - Complete 24 credits of 600- or 700-level MAT or STA courses (excluding MAT 711 & 712), or other advisor-approved courses.
- Dissertation – Credits: 18
    - STA 799 - Dissertation

Degree Requirements

See Plan Degree Requirements below.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 5 Requirements: Post-Master's - Applied Mathematics Track

Credits Required: 48

Course Requirements

- Required Courses Part 1– Credits: 6
    - Complete two analysis or two theory courses:
        - MAT 707 - Real Analysis I
        - MAT 708 - Real Analysis II

          OR
        - MAT 709 - Complex Function Theory I
        - MAT 710 - Complex Function Theory II
- Required Courses Part 2 – Credits: 6
    - MAT 771 - Applied Analysis I
    - MAT 772 - Applied Analysis II
- Subject Area Courses – Credits: 12
    - Complete two of the following one-year course sequences:
        - MAT 703 - Abstract Algebra III
        - MAT 704 - Abstract Algebra IV
        - MAT 723 - Advanced Ordinary Differential Equations I
        - MAT 724 - Advanced Ordinary Differential Equations II
        - MAT 729 - Partial Differential Equations I
        - MAT 730 - Partial Differential Equations II
        - MAT 733 - Topology
        - MAT 734 - Topology
        - MAT 765 - Advanced Numerical Analysis
        - MAT 766 - Advanced Numerical Analysis
        - STA 767 - Mathematical Statistics I
        - STA 768 - Mathematical Statistics II
- Elective Courses – Credits: 6
    - Complete 6 credits of 600- or 700-level MAT or STA courses (excluding MAT 711 & 712), or other advisor-approved courses.
- Dissertation – Credits: 18
    - MAT 799 - Dissertation

Degree Requirements

See Plan Degree Requirements below.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 6 Requirements: Post-Master's - Computational Mathematics Track

Total Credits Required: 48

Course Requirements

- Required Courses Part 1 – Credits: 6
  - Complete two analysis or two theory courses:
    - MAT 707 - Real Analysis I
    - MAT 708 - Real Analysis II

      OR
    - MAT 709 - Complex Function Theory I
    - MAT 710 - Complex Function Theory II
- Required Courses Part 2 – Credits: 6
  - MAT 765 - Advanced Numerical Analysis
  - MAT 766 - Advanced Numerical Analysis
- Subject Area Courses – Credits: 12
  - Complete two of the following one-year course sequences:
    - MAT 703 - Abstract Algebra III
    - MAT 704 - Abstract Algebra IV
    - MAT 723 - Advanced Ordinary Differential Equations I
    - MAT 724 - Advanced Ordinary Differential Equations II
    - MAT 729 - Partial Differential Equations I
    - MAT 730 - Partial Differential Equations II
    - MAT 733 - Topology
    - MAT 734 - Topology
    - MAT 771 - Applied Analysis I
    - MAT 772 - Applied Analysis II
    - STA 767 - Mathematical Statistics I
    - STA 768 - Mathematical Statistics II
- Elective Courses – Credits: 6
  - Complete 6 credits of 600- or 700-level MAT or STA courses (excluding MAT 711 & 712), or other advisor-approved courses.
- Dissertation – Credits: 18
  - MAT 799 - Dissertation

Degree Requirements

See Plan Degree Requirements below.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 7 Requirements: Post-Master's - Pure Mathematics Track

Total Credits Required: 48

Course Requirements

- Required Courses Part 1 – Credits: 6
  - Complete two analysis or two theory courses:
    - MAT 707 - Real Analysis I
    - MAT 708 - Real Analysis II

      OR
    - MAT 709 - Complex Function Theory I
    - MAT 710 - Complex Function Theory II
- Required Courses Part 2 – Credits: 6
  - MAT 703 - Abstract Algebra III
  - MAT 704 - Abstract Algebra IV
- Subject Area Courses – Credits: 12
  - Complete two of the following one-year course sequences:
    - MAT 701 - Foundations of Mathematics III
    - MAT 702 - Foundations of Mathematics IV
    - MAT 717 - Analytical Solution Methods for Partial Differential Equations, I
    - MAT 718 - Analytical Solution Methods for Partial Differential Equations, II
    - MAT 723 - Advanced Ordinary Differential Equations I
    - MAT 724 - Advanced Ordinary Differential Equations II
    - MAT 733 - Topology
    - MAT 734 - Topology
    - MAT 771 - Applied Analysis I
    - MAT 772 - Applied Analysis II
    - STA 767 - Mathematical Statistics I
    - STA 768 - Mathematical Statistics II
- Elective Courses – Credits: 6
  - Complete 6 credits of 600- or 700-level MAT or STA courses (excluding MAT 711 & 712), or other advisor-approved courses.
- Dissertation – Credits: 18
  - MAT 799 - Dissertation

Degree Requirements

See Plan Degree Requirements below.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 8 Requirements: Post-Master's - Statistics Track

Total Credits Required: 48

Course Requirements

- Required Courses Part 1 – Credits: 6
  - STA 767 - Mathematical Statistics I
  - STA 768 - Mathematical Statistics II
- Required Courses Part 2 – Credits: 6
  - STA 761 - Regression Analysis I
  - STA 762 - Regression Analysis II
- Subject Area Courses – Credits: 12
  - Complete two of the following one-year course sequences:
    - STA 713 - Experimental Design
    - STA 715 - Multivariate Statistical Methods
    - STA 750 - Time Series Analysis
    - STA 751 - Spatial Statistics
    - STA 755 - Stochastic Modeling I
    - STA 756 - Stochastic Modeling II
    - STA 753 - Bayesian Data Analysis
    - STA 765 - Statistical Decision Theory
    - STA 763 - Analysis of Variance I
    - STA 764 - Analysis of Variance II
    - MAT 707 - Real Analysis I
    - STA 731 - Probability Theory and Its Applications
- Elective Courses – Credits: 6
  - Complete 6 credits of 600- or 700-level MAT or STA courses (excluding MAT 711 & 712), or other advisor-approved courses.
- Dissertation – Credits: 18
  - STA 799 - Dissertation

Degree Requirements

See Plan Degree Requirements below.

Graduation Requirements

See Plan Graduation Requirements below.

Plan Degree Requirements

- Students in a post-bachelor's track must complete a minimum of 60 credits of course work (excluding dissertation), at least 18 of which must be at the 700-level.
- Students in a post-master's track must complete a minimum of 30 credits of course work (excluding dissertation), at least 18 of which must be at the 700-level.
- A student must enroll in a minimum of 18 credits of Dissertation.
- In consultation with his/her advisor, a student will organize a dissertation committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate

College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.

- Qualifying Examination. The purpose of the Qualifying Examination is to measure the student's knowledge of basic graduate course work in selected areas and to make sure that the student is prepared to proceed to more advanced studies.
- A doctoral student normally takes the Qualifying Examination within the second year after entering the program, based on the core courses in the student's concentration.
- Doctoral students must pass the Qualifying Examination within three years.
- The Qualifying Examination consists of two parts, corresponding to Required Courses Part 1 & Part2.
- A student who fails the Qualifying Examination on the first attempt will be placed on probation and must complete a second examination within the next twelve months.
- A post-bachelor's track student who fails the second examination may be allowed to complete a M.S. degree with the consent of the Graduate Studies Committee. Such a student will not be permitted to seek readmission to the Doctoral Program in Mathematical Sciences at UNLV.
- A post-master's track student who fails the Qualifying Examination a second time will be separated from the program.
- Subject Area Breadth Requirements. With the goal of encouraging students to be exposed to a broad spectrum of mathematics during their graduate studies, doctoral students are required to take at least two one-year sequence courses with a grade of B or better, in addition to the core courses tested by the Ph.D. Qualifying Examination.
- The purpose of the Comprehensive Examination is to measure a doctoral student's knowledge of the advanced level graduate work that will be required as the student begins to do original research in his or her area of concentration.
- After passing the Qualifying Examination, a student will engage in the approved course work specified by the Doctoral Advisory Committee and submit to the latter a dissertation proposal.
- Usually one year after passing the Qualifying Examination, a student will complete the Comprehensive Examination, designed and administered by the Doctoral Advisory Committee, based on the student's course work with focus on his/her ability to perform research on the dissertation proposal.
- A student who fails the Comprehensive Examination on the first attempt must complete a second examination within the next semester. A student who fails the examination a second time will be separated from the Doctoral Program.
- A student who has successfully passed the Comprehensive Examination will be admitted to Candidacy for the Ph.D. degree and thereby be allowed to proceed with the approved dissertation proposal.
- A doctoral candidate is expected to complete a dissertation embodying the results of significant original research, which is performed independently by the student, and is acceptable to the student's advisory committee.
- Skills in foreign languages, computer programming and/or interdisciplinary areas, dependent on the concentration of a student's program, will be determined by the Doctoral Advisory Committee and the Graduate Studies Committee in consultation with the Department Chair.
- Dissertation Defense. After submitting to the Doctoral Advisory Committee a dissertation draft that was approved by his/her Dissertation Advisor, a candidate will defend orally the dissertation before the Doctoral Advisory Committee and any other graduate faculty members who wish to attend. The Doctoral Advisory Committee will recommend to the Graduate Coordinator/Department Chair whether the dissertation and defense are both satisfactory.
- Specific degree requirements, including those listed above, are described in detail in the Graduate Student Handbook for the Ph.D. Program, available on the department's web site. The listing of graduate courses is constantly under review. Graduate students will automatically receive new listings. Since some courses are taught on an "on demand" basis, course prerequisites for each of the four concentrations are considered

guidelines with courses roughly equivalent accepted as prerequisites, subject to approval of the Graduate Studies Committee and the student's Doctoral Advisory Committee.

- A student will be placed on academic probation if a minimum of 3.00 GPA is not maintained in all work taken in the degree program. A grade of C or less in one graduate-level course will cause a student to be placed on academic probation and will elicit a critical review of the student's program by the Graduate Studies Committee.
- The Graduate College requires a minimum of 50 percent of the total credits required to complete the doctoral degree, exclusive of transferred credits and/or the dissertation, must be earned at UNLV after admission to a graduate degree program.

Plan Graduation Requirements

- The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
- The student must submit and successfully defend his/her dissertation by the posted deadline. The defense must be advertised and is open to the public.
- The student must submit his/her approved, properly formatted hard-copy dissertation to the Graduate College, and submit the approved electronic version to ProQuest by the posted deadline.

Dual Degree: Master of Arts - Economics & Master of Science - Mathematical Sciences

Plan Description

The dual Master of Arts – Economics and Master of Science – Mathematical Sciences combine economic reasoning with mathematical methods. The program attracts students with focused career choices that require core competence in analytical skills and mathematical methods. It also prepares students with interests in pursuing a Ph.D. in economics with substantial quantitative skills, or a Ph.D. in Mathematics with economic applications. We believe that the analytical nature of the program will attract high quality undergraduates.

The MA – Economics portion of the dual degree program advances students' knowledge in macro- and micro-economic theory. It also provides students with econometrics as well as developing their communication skills. The MS – Mathematical Sciences portion of the dual degree program is designed to equip graduate students with a solid foundation of mathematics, statistics, and real-world applications.

The MS – Mathematical Sciences portion of the dual degree is designed to equip graduate students with a solid foundation of mathematics, statistics, and real-world applications. The MA – Economics portion of the dual degree advances students' knowledge in macro- and micro-economic theory. It also provides students with econometrics as well as developing their communication skills.

Learning Outcomes

www.unlv.edu/degree/dual-ms-math-ma-economics

Plan Admission Requirements

The Departments of Economics and Mathematical Sciences welcome applications from college graduates in all fields. All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements. Applicants must satisfy the minimum admission requirements of the MA – Economics

program and the MS – Mathematics program. If denied by one program, the applicant will have the option of proceeding with a single degree program with departmental approval.

Plan Requirements

Total Credits Required: 51

Course Requirements

Total Credits Required for the Economics M.A.: 24

- Required Courses – Credits: 18
    - ECO 701 - Macroeconomic Theory
    - ECO 702 - Microeconomic Theory
    - ECO 740 - Mathematical Economics
    - ECO 770 - Econometrics I, Statistical Modeling
    - ECO 772 - Econometrics II
    - ECO 793 - Seminar in Economic Research
- Elective Courses – Credits: 3
    - Complete 3 credits of ECO electives at the 600- or 700-level.
- Professional Paper – Credits: 3
    - ECO 794 - Professional Paper

Total Credits Required for the Mathematical Sciences M.S.: 27

- Required Courses – Credits: 18
    - Complete 18 credits from the following list of courses:
        - MAT 657 - Introduction to Real Analysis I
        - MAT 663 - Advanced Matrix Theory and Applications
        - MAT 707 - Real Analysis I
        - MAT 709 - Complex Function Theory I
        - MAT 723 - Advanced Ordinary Differential Equations I
        - MAT 771 - Applied Analysis I
        - STA 761 - Regression Analysis I
        - STA 762 - Regression Analysis II
        - STA 767 - Mathematical Statistics I
        - STA 768 - Mathematical Statistics II
- Elective Courses – Credits: 3
    - Complete 3 credits of 600- or 700-level MAT or STA courses (excluding MAT 711 & 712), or other advisor-approved graduate-level courses.
- Thesis – Credits: 6
    - Complete six credits in one of the following courses:
        - MAT 791 - Thesis
        - STA 791 - Thesis

Degree Requirements

- A minimum of 51 credits of graduate work is required for the Dual M.S. and M.A. Program in Mathematics and Economics.

- Completion of a minimum of 24 credits for the Economics M.A. and a minimum of 27 credits for the Mathematical Sciences M.S. with a minimum GPA of 3.00.
- 18 of the 21 credits of economics coursework (excluding professional paper) must be at the 700-level.
- 15 of the 21 credits of mathematics coursework (excluding thesis) must be at the 700-level.
- A student will be placed on academic probation if a minimum of 3.00 GPA is not maintained in all work taken in the degree program. A grade of C or less in one graduate-level course will cause a student to be placed on academic probation and will elicit a critical review of the student's program by the Graduate Studies Committee. Failure to meet the requirements of probation will result in separation from the graduate program.
- Classes in which a student receives a C or lower will not count towards his or her degree.
- Students are required to defend a thesis on subjects in the interdisciplinary area of Mathematics and Economics. The committee chair and two other committee members must be from the Mathematics Department. The thesis committee must be composed at minimum of two graduate faculty members from the Economics Department. Please see Graduate College policy for committee appointment guidelines.
- Students are required to complete a professional paper. The committee for the professional paper must be composed of a chair and two committee members from the Economics Department and one graduate faculty member from the Mathematics Department.

Plan Graduation Requirements

- Students cannot graduate from one portion of the dual degree until the requirements for both are met. Students must apply to graduate from both programs for the same semester.
- The student must submit all required forms to the Graduate College and then apply for graduation from both degrees up to two semesters prior to completing his/her degree requirements.
- The student must successfully complete a professional paper.
- Submit and successfully defend his/her thesis by the posted deadline. The defense must be advertised and is open to the public.
- Submit his/her approved, properly formatted hard-copy thesis to the Graduate College, and submit the approved electronic version to ProQuest by the posted deadline.
- Dual Degree: Doctor of Philosophy - Electrical Engineering & Master of Science - Mathematical Sciences

Dual Degree: Doctor of Philosophy - Electrical Engineering & Master of Science - Mathematical Sciences

Plan Description

The dual Ph.D. EE and M.S. MAT program of study is designed for those who want to pursue a Ph.D. degree in Electrical Engineering or a career in Electrical Engineering with emphasis in applied mathematics. The program prepares graduate students with complementing educational components covering electrical engineering and mathematics, which is the basis of all engineering.

The culminating experience in the Ph.D. program in the Department of Electrical and Computer Engineering is centered about developing new knowledge focused around a specific theme embodied in the form a well-written and orally defended dissertation. The Department of Electrical and Computer Engineering at UNLV offers a number of program options leading to the Ph.D. degree in the Field of Electrical Engineering. Specific major areas of study currently available include: Communications, Computer Engineering, Control System Theory, Electromagnetics and Optics, Electronics, Power Systems, Signal Processing, and Solid State Materials and Devices.

Plan Admission Requirements

Applicants are considered on an individual basis. All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements.

Applicants must satisfy the minimum requirements of the Ph.D. – Electrical Engineering program, and the M.S. – Mathematics program. If denied by one program, the applicant will have the option of proceeding with a single degree program with departmental approval.

Plan Requirements

See Subplan Requirements below.

Subplan 1 Requirements: Post-Master's Track

Total Credits Required: 69-72

Course Requirements

Total Credits Required for the Mathematical Sciences M.S.: 30-33

- Required Courses – Credits: 6
    - Complete two of the following courses:
        - MAT 707 - Real Analysis I
        - MAT 709 - Complex Function Theory I
        - MAT 765 - Advanced Numerical Analysis
- Elective Courses – Credits: 21-24
    - Students completing the exam option must complete a minimum of 24 credits of MAT or STA elective courses (excluding MAT 711 & 712), and students completing the thesis option must complete a minimum of 21 credits of MAT or STA elective courses (excluding MAT 711 & 712). Other graduate-level courses may be taken with advisor-approval.
- Thesis – Credits: 6 (Optional)
    - Complete 6 credits from one of the following courses:
        - MAT 791 - Thesis
        - STA 791 - Thesis

Total Credits Required for the Electrical Engineering Ph.D.: 45

- Major Field Courses – Credits: 6-15
    - Complete 6-15 credits of coursework in an approved major in a single area in Electrical and Computer Engineering with a minimum overall average GPA of 3.33.
        - Communications
            - ECG 662 - Advanced Digital Communications
            - ECG 704 - Coding with Applications in Computers and Communication Media
            - ECG 760 - Random Processes in Engineering Problems
            - ECG 762 - Detection and Estimation of Signals in Noise
        - Computer Engineering

    - ECG 600 - Computer Communication Networks
    - ECG 603 - Embedded Systems Design
    - ECG 604 - Modern Processor Architecture
    - ECG 605 - Data Compression Systems
    - ECG 607 - Biometrics
    - ECG 608 - Digital Design Verification and Testing
    - ECG 700 - Advanced Computer System Architecture
    - ECG 701 - Reliable Design of Digital Systems
    - ECG 702 - Interconnection Networks for Parallel Processing Applications
    - ECG 704 - Coding with Applications in Computers and Communication Media
    - ECG 706 - Analysis of Telecommunication and Data Networks
    - ECG 707 - Logic Synthesis Engineering
    - ECG 709 - Synthesis and Optimization of Digital Systems
- Control Systems Theory
    - ECG 672 - Digital Control Systems
    - ECG 674 - Recent Topics in Control
    - ECG 770 - Linear Systems Theory
    - ECG 771 - Optimal and Modern Controls
    - ECG 772 - Nonlinear Systems I
    - ECG 774 - Stochastic Control
    - ECG 776 - Adaptive Control
- Electromagnetics and Optics
    - ECG 630 - Transmission Lines
    - ECG 631 - Engineering Optics
    - ECG 632 - Antenna Engineering
    - ECG 633 - Active and Passive Microwave Engineering
    - ECG 730 - Advanced Engineering Electromagnetics I
    - ECG 731 - Theoretical Techniques in Electromagnetics
    - ECG 732 - Advanced Engineering Electromagnetics II
    - ECG 733 - Plasma I
- Electronics
    - ECG 620 - Analog Integrated Circuit Design
    - ECG 621 - Digital Integrated Circuit Design
    - ECG 720 - Advanced Analog IC Design
    - ECG 721 - Memory Circuit Design
    - ECG 722 - Mixed-Signal Circuit Design
- Power Engineering
    - ECG 642 - Power Electronics
    - ECG 646 - Photovoltaic Devices and Systems
    - ECG 740 - Computer Analysis Methods for Power Systems
    - ECG 741 - Electric Power Distribution System Engineering
    - ECG 742 - Power System Stability and Control
- Signal Processing
    - ECG 680 - Discrete-Time Signal Processing
    - ECG 762 - Detection and Estimation of Signals in Noise
    - ECG 781 - Digital Filters

            - ECG 782 - Multidimensional Digital Signal Processing
            - ECG 783 - Adaptive Signal Processing with Neural Networks
        - Solid State Electronics
            - ECG 651 - Electronic and Magnetic Materials and Devices
            - ECG 652 - Optoelectronics
            - ECG 653 - Introduction to Nanotechnology
            - ECG 750 - Optical Electronics I
            - ECG 752 - Physical Electronics
            - ECG 753 - Advanced Topics in Semiconductor Devices I
            - ECG 755 - Monolithic Integrated Circuit Fabrication
            - ECG 756 - Advanced Topics in Semiconductor Devices II
            - ECG 757 - Electron Transport Phenomena in Solid State Devices
- Minor Fields Courses – Credits: 6-18
    - Select two advisor-approved minor fields and complete coursework in each single area totaling 6-18 credits, with a minimum overall average GPA of 3.33. The secondary minor can be from a field outside Electrical Engineering.
        - Communications
            - ECG 662 - Advanced Digital Communications
            - ECG 704 - Coding with Applications in Computers and Communication Media
            - ECG 760 - Random Processes in Engineering Problems
            - ECG 762 - Detection and Estimation of Signals in Noise
        - Computer Engineering
            - ECG 600 - Computer Communication Networks
            - ECG 603 - Embedded Systems Design
            - ECG 604 - Modern Processor Architecture
            - ECG 605 - Data Compression Systems
            - ECG 607 - Biometrics
            - ECG 608 - Digital Design Verification and Testing
            - ECG 700 - Advanced Computer System Architecture
            - ECG 701 - Reliable Design of Digital Systems
            - ECG 702 - Interconnection Networks for Parallel Processing Applications
            - ECG 704 - Coding with Applications in Computers and Communication Media
            - ECG 706 - Analysis of Telecommunication and Data Networks
            - ECG 707 - Logic Synthesis Engineering
            - ECG 709 - Synthesis and Optimization of Digital Systems
        - Control Systems Theory
            - ECG 770 - Linear Systems Theory
            - ECG 771 - Optimal and Modern Controls
            - ECG 772 - Nonlinear Systems I
        - Electromagnetics and Optics
            - ECG 630 - Transmission Lines
            - ECG 631 - Engineering Optics
            - ECG 632 - Antenna Engineering
            - ECG 633 - Active and Passive Microwave Engineering
            - ECG 730 - Advanced Engineering Electromagnetics I
            - ECG 731 - Theoretical Techniques in Electromagnetics
            - ECG 732 - Advanced Engineering Electromagnetics II

            - ECG 733 - Plasma I
        - Electronics
            - ECG 620 - Analog Integrated Circuit Design
            - ECG 621 - Digital Integrated Circuit Design
            - ECG 720 - Advanced Analog IC Design
            - ECG 721 - Memory Circuit Design
            - ECG 722 - Mixed-Signal Circuit Design
        - Power Engineering
            - ECG 642 - Power Electronics
            - ECG 646 - Photovoltaic Devices and Systems
            - ECG 740 - Computer Analysis Methods for Power Systems
            - ECG 741 - Electric Power Distribution System Engineering
            - ECG 742 - Power System Stability and Control
        - Signal Processing
            - ECG 680 - Discrete-Time Signal Processing
            - ECG 762 - Detection and Estimation of Signals in Noise
            - ECG 781 - Digital Filters
        - Solid State Electronics
            - ECG 651 - Electronic and Magnetic Materials and Devices
            - ECG 652 - Optoelectronics
            - ECG 653 - Introduction to Nanotechnology
            - ECG 750 - Optical Electronics I
            - ECG 752 - Physical Electronics
            - ECG 753 - Advanced Topics in Semiconductor Devices I
            - ECG 755 - Monolithic Integrated Circuit Fabrication
            - ECG 756 - Advanced Topics in Semiconductor Devices II
            - ECG 757 - Electron Transport Phenomena in Solid State Devices
- Elective Courses – Credits: 0-12
    - Complete 0-12 credits of 600- or 700-level MAT, PHY, AST, CEE, CEM, ECG, EGG, CS, ME, or other advisor-approved courses.
- Dissertation – Credits: 18
    - ECG 799 - Dissertation

Total Credits Shared: 6

- Two courses can be double counted between Electrical Engineering Ph.D. and Mathematical Sciences M.S. degrees. Non-ECG courses must be applied towards non-ECG elective credits in the electrical engineering degree program pursued.

Degree Requirements

- A minimum 69 or 72 credits (including thesis and dissertation credits) is required for the Dual Electrical Engineering Ph.D. and Mathematical Sciences M.S. which corresponds to the choice of completing a Mathematics comprehensive exam or thesis.
- Two of the courses included in the degree program can be double counted in the Electrical Engineering Ph.D. and Mathematical Sciences M.S. degrees. Non-ECG courses must be applied towards non-ECG elective credits in the electrical engineering degree program pursued.

Mathematical Sciences M.S

- Students completing a thesis must complete a minimum of 33 credit hours with a minimum GPA of 3.00.
- Students completing the comprehensive exam must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
- For the master's degree 21 credits of mathematics course work must be at the 700-level (excluding thesis).
- A student will be placed on academic probation if a minimum of 3.00 GPA is not maintained in all work taken in the degree program. A grade of C or less in one graduate-level course will cause a student to be placed on academic probation and will elicit a critical review of the student's program by the Graduate Studies Committee.
- The Graduate College requires a minimum of 50 percent of the total credits required to complete the graduate degree, exclusive of transferred credits and/or the thesis, must be earned at UNLV after admission to a graduate degree program.
- Students must complete a final examination. This will be either an examination to defend the thesis or a written comprehensive examination based on requirements 1 and 2.
- If the thesis option is chosen: In consultation with his/her advisor, a student will organize a dissertation committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.

Electrical Engineering Ph.D.

- All Ph.D. students must satisfy the Ph.D. degree program admission requirements and be admitted to the Ph.D. program on a regular status.
- Complete a minimum of 27 credits of graduate level courses (excluding dissertation credits) with an overall minimum GPA of 3.20 and a minimum GPA of 2.70 (B-) in each class applied towards the 27 credits. The final division of major, minor, and elective credits will be determined in consultation with the student's advisor.
- Of the 27 required credits, a minimum of 18 credits must be in 700-level courses. Of these 18 credits, a minimum of 15 must be from formal courses. The student's doctoral advisory committee may add more requirements in accordance with the individual's background and field of study.
- No more than 3 credits may be from Graduate Independent Study together with Graduate Seminar. No more than 6 credits of a combination of informal courses such as Graduate Independent Study, Special Topics, and Seminar may be applied to the degree program.
- Beyond the Bachelor degree, a Ph.D. student must complete a minimum of 15 credits in an approved ECE major field, 9 credits an approved ECE minor (primary minor) field, and 9 credits in a second approved open minor (secondary minor) field. Of the 15 credits required in the ECE major field, a minimum of 9 credits must be completed in 700-level courses. A minimum GPA of 3.33 (B+=3.30) must be obtained in the major field. Of the 9 required credits in each minor field, a minimum of 6 credits must be in 700-level courses. A minimum GPA of 3.33 (B+=3.30) must be obtained in each of the minor fields.
- Informal courses (Graduate Independent Study, Graduate Seminar, and Special Topics) cannot be applied to the ECE major, ECE minor (primary minor) and the open minor (secondary minor) fields.

- At the time of admission or no later than the first semester, the Ph.D. candidate must formally petition BOTH the graduate college and the ECE graduate committee to accept transfer credits and credits taken as a non-degree seeking graduate student to be applied to the Ph.D. program.
- All regular (full graduate standing) status graduate students must select a faculty advisor in their first semester.
- Maintain a minimum overall grade point average (GPA) of 3.20, must maintain a minimum GPA of 3.20 each semester, and must complete all graduate level courses that apply towards their degree with a minimum GPA of 2.70 (B-) in each course. Grades below B- cannot be applied towards the Ph.D. degree and must be repeated or replaced. A class grade below C (2.0) is grounds for initiating a program separation recommendation to the Graduate College. Ph.D. candidates who do not maintain an overall minimum GPA of 3.2, who do not maintain a minimum GPA of 3.2 each semester, or who earn more than one grade below B- will be placed on academic probation or expelled from the program. The Electrical and Computer Engineering Graduate Committee in conjunction with the Graduate College will determine the terms of the student's probation based upon the student's academic record and in accordance with the rules of the Graduate College.
- All regular (full graduate standing) status graduate students must file an approved program before the completion of their third semester. This program must be approved by the student's advisor and the graduate coordinator. All regular and provisional status graduate students must show satisfactory progress towards completion of their degree by completing at least six credits of their approved program per calendar year. If their progress towards their degree program is not satisfactory, students will either be put on probation or expelled from the program.
- Before beginning a dissertation, students must have their dissertation topic approved by their advisor, and the necessary paper work including a dissertation prospectus must be filed with the Graduate College by the end of the third semester. The dissertation prospectus describes the dissertation topic and must include an introductory set of sentences, a well formed hypothesis or hypotheses (specifically italicized in the prospectus) accompanied by a motivation, objectives with major and alternative approaches to the studies, and conjectures of possible outcomes. Students are NOT allowed to take dissertation credits until their prospectus is approved. Credits taken before the approval date will NOT count towards the degree program.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 2 Requirements: Post-Bachelor's Track

Total Credits Required: 93-96

Course Requirements

Total Credits Required for the Mathematical Sciences M.S.: 30-33

- Required Courses – Credits: 6
    - Complete two of the following courses:
        - MAT 707 - Real Analysis I
        - MAT 709 - Complex Function Theory I
        - MAT 765 - Advanced Numerical Analysis
- Elective Courses – Credits: 21-24

    - Students completing the exam option must complete a minimum of 24 credits of MAT or STA elective courses (excluding MAT 711 & 712), and students completing the thesis option must complete a minimum of 21 credits of MAT or STA elective courses (excluding MAT 711 & 712). Other graduate-level courses may be taken with advisor-approval.
- Thesis – Credits: 6 (Optional)
    - Complete 6 credits from one of the following courses:
        - MAT 791 - Thesis
        - STA 791 - Thesis

Total Credits Required for the Electrical Engineering Ph.D.: 69

- Major Field Courses – Credits: 15
    - Complete 15 credits of coursework in an approved major in a single area in Electrical and Computer Engineering with a minimum overall GPA of 3.33. A minimum of 9 credits must be in 700-level courses.
        - Communications
            - ECG 662 - Advanced Digital Communications
            - ECG 704 - Coding with Applications in Computers and Communication Media
            - ECG 760 - Random Processes in Engineering Problems
            - ECG 762 - Detection and Estimation of Signals in Noise
        - Computer Engineering
            - ECG 600 - Computer Communication Networks
            - ECG 603 - Embedded Systems Design
            - ECG 604 - Modern Processor Architecture
            - ECG 605 - Data Compression Systems
            - ECG 607 - Biometrics
            - ECG 608 - Digital Design Verification and Testing
            - ECG 700 - Advanced Computer System Architecture
            - ECG 701 - Reliable Design of Digital Systems
            - ECG 702 - Interconnection Networks for Parallel Processing Applications
            - ECG 704 - Coding with Applications in Computers and Communication Media
            - ECG 706 - Analysis of Telecommunication and Data Networks
            - ECG 707 - Logic Synthesis Engineering
            - ECG 709 - Synthesis and Optimization of Digital Systems
        - Control Systems Theory
            - ECG 672 - Digital Control Systems
            - ECG 674 - Recent Topics in Control
            - ECG 770 - Linear Systems Theory
            - ECG 771 - Optimal and Modern Controls
            - ECG 772 - Nonlinear Systems I
            - ECG 774 - Stochastic Control
            - ECG 776 - Adaptive Control
        - Electromagnetics and Optics
            - ECG 630 - Transmission Lines
            - ECG 631 - Engineering Optics
            - ECG 632 - Antenna Engineering

            - ECG 633 - Active and Passive Microwave Engineering
            - ECG 730 - Advanced Engineering Electromagnetics I
            - ECG 731 - Theoretical Techniques in Electromagnetics
            - ECG 732 - Advanced Engineering Electromagnetics II
            - ECG 733 - Plasma I
        - Electronics
            - ECG 620 - Analog Integrated Circuit Design
            - ECG 621 - Digital Integrated Circuit Design
            - ECG 720 - Advanced Analog IC Design
            - ECG 721 - Memory Circuit Design
            - ECG 722 - Mixed-Signal Circuit Design
        - Power Engineering
            - ECG 642 - Power Electronics
            - ECG 646 - Photovoltaic Devices and Systems
            - ECG 740 - Computer Analysis Methods for Power Systems
            - ECG 741 - Electric Power Distribution System Engineering
            - ECG 742 - Power System Stability and Control
        - Signal Processing
            - ECG 680 - Discrete-Time Signal Processing
            - ECG 762 - Detection and Estimation of Signals in Noise
            - ECG 781 - Digital Filters
            - ECG 782 - Multidimensional Digital Signal Processing
            - ECG 783 - Adaptive Signal Processing with Neural Networks
        - Solid State Electronics
            - ECG 651 - Electronic and Magnetic Materials and Devices
            - ECG 652 - Optoelectronics
            - ECG 653 - Introduction to Nanotechnology
            - ECG 750 - Optical Electronics I
            - ECG 752 - Physical Electronics
            - ECG 753 - Advanced Topics in Semiconductor Devices I
            - ECG 755 - Monolithic Integrated Circuit Fabrication
            - ECG 756 - Advanced Topics in Semiconductor Devices II
            - ECG 757 - Electron Transport Phenomena in Solid State Devices
- Minor Fields Courses – Credits: 18
    - Select two advisor-approved minor fields and complete 9 credits of coursework in each single area with a minimum overall average GPA of 3.33. A minimum of 6 credits in each area must be in 700-level courses. The secondary minor can be from a field outside Electrical Engineering.
        - Communications
            - ECG 662 - Advanced Digital Communications
            - ECG 704 - Coding with Applications in Computers and Communication Media
            - ECG 760 - Random Processes in Engineering Problems
            - ECG 762 - Detection and Estimation of Signals in Noise
        - Computer Engineering
            - ECG 600 - Computer Communication Networks
            - ECG 603 - Embedded Systems Design
            - ECG 604 - Modern Processor Architecture
            - ECG 605 - Data Compression Systems

    - ECG 607 - Biometrics
    - ECG 608 - Digital Design Verification and Testing
    - ECG 700 - Advanced Computer System Architecture
    - ECG 701 - Reliable Design of Digital Systems
    - ECG 702 - Interconnection Networks for Parallel Processing Applications
    - ECG 704 - Coding with Applications in Computers and Communication Media
    - ECG 706 - Analysis of Telecommunication and Data Networks
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    - ECG 652 - Optoelectronics
    - ECG 653 - Introduction to Nanotechnology
    - ECG 750 - Optical Electronics I
    - ECG 752 - Physical Electronics
    - ECG 753 - Advanced Topics in Semiconductor Devices I
    - ECG 755 - Monolithic Integrated Circuit Fabrication

        - ECG 756 - Advanced Topics in Semiconductor Devices II
        - ECG 757 - Electron Transport Phenomena in Solid State Devices
- 700-Level Elective Courses – Credits: 12
    - Complete 12 credits of 700-level MAT, PHY, AST, CEE, CEM, ECG, EGG, CS, ME, or other advisor-approved courses.
- Elective Courses – Credits: 6
    - Complete 6 credits of 600- or 700-level MAT, PHY, AST, CEE, CEM, ECG, EGG, CS, ME, or other advisor-approved courses.
- Dissertation – Credits: 18
    - ECG 799 - Dissertation

Total Credits Shared: 6

- Two courses can be double counted between Electrical Engineering Ph.D. and Mathematical Sciences M.S. degrees. Non-ECG courses must be applied towards non-ECG elective credits in the electrical engineering degree program pursued.

Degree Requirements

- A minimum 93 or 96 credits (including thesis and dissertation credits) is required for the Dual Electrical Engineering Ph.D. and Mathematical Sciences M.S. which corresponds to the choice of completing a Mathematics comprehensive exam or thesis.
- Two of the courses included in the degree program can be double counted Electrical Engineering M.S.E and Mathematical Sciences M.S. degrees. Non-ECG courses must be applied towards non-ECG elective credits in the electrical engineering degree program pursued.

Mathematical Sciences M.S

- Students completing a thesis must complete a minimum of 33 credit hours with a minimum GPA of 3.00.
- Students completing the comprehensive exam must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
- 21 credits of mathematics course work must be at the 700-level (excluding thesis).
- A student will be placed on academic probation if a minimum of 3.00 GPA is not maintained in all work taken in the degree program. A grade of C or less in one graduate-level course will cause a student to be placed on academic probation and will elicit a critical review of the student's program by the Graduate Studies Committee.
- The Graduate College requires a minimum of 50 percent of the total credits required to complete the graduate degree, exclusive of transferred credits and/or the thesis, must be earned at UNLV after admission to a graduate degree program.
- Students must complete a final examination. This will be either an examination to defend the thesis or a written comprehensive examination based on requirements 1 and 2.
- If the thesis option is chosen: In consultation with his/her advisor, a student will organize a dissertation committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.

Electrical Engineering Ph.D.

- All Ph.D. students must satisfy the Ph.D. degree program admission requirements and be admitted to the Ph.D. program on a regular status.
- Complete a minimum of 51 credits (24 M.S.E. credits + 27 Post-Master's Track credits) of graduate level courses (excluding dissertation credits) with an overall minimum GPA of 3.20 and a minimum GPA of 2.70 (B-) in each class applied towards the 27 credits.
- Of the 51 required credits, a minimum of 33 credits must be in 700-level courses. Of these 33 credits, a minimum of 30 must be from formal courses. The student's doctoral advisory committee may add more requirements in accordance with the individual's background and field of study.
- No more than 6 credits may be from Graduate Independent Study together with Graduate Seminar. No more than 12 credits of a combination of informal courses such as Graduate Independent Study, Special Topics, and Seminar may be applied to the degree program.
- Complete a minimum of 15 credits in an approved ECE major field, 9 credits an approved ECE minor (primary minor) field, and 9 credits in a second approved open minor (secondary minor) field. Of the 15 credits required in the ECE major field, a minimum of 9 credits must be completed in 700-level courses. A minimum GPA of 3.33 (B+=3.30) must be obtained in the major field. Of the 9 required credits in each minor field, a minimum of 6 credits must be in 700-level courses. A minimum GPA of 3.33 (B+=3.30) must be obtained in each of the minor fields.
- Informal courses (Graduate Independent Study, Graduate Seminar, and Special Topics) cannot be applied to the ECE major, ECE minor (primary minor) and the open minor (secondary minor) fields.
- At the time of admission or no later than the first semester, the Ph.D. candidate must formally petition BOTH the graduate college and the ECE graduate committee to accept transfer credits and credits taken as a non-degree seeking graduate student to be applied to the Ph.D. program.
- All regular (full graduate standing) status graduate students must select a faculty advisor in their first semester.
- Students on academic probation may be transferred to the M.S.E. Program depending on the student's academic record. In such a case, the M.S.E. Program requirements must be satisfied. For example, only 6 credits of the informal courses may be applied to the M.S.E. degree program with the further constraint that up to 3 credits total of Independent Study in combination with Graduate Seminar may be in the 6 credits.
- Maintain a minimum overall grade point average (GPA) of 3.20, must maintain a minimum GPA of 3.20 each semester, and must complete all graduate level courses that apply towards their degree with a minimum GPA of 2.70 (B-) in each course. Grades below B- cannot be applied towards the Ph.D. degree and must be repeated or replaced. A class grade below C (2.0) is grounds for initiating a program separation recommendation to the Graduate College. Ph.D. candidates who do not maintain an overall minimum GPA of 3.2, who do not maintain a minimum GPA of 3.2 each semester, or who earn more than one grade below B- will be placed on academic probation or expelled from the program. The Electrical and Computer Engineering Graduate Committee and/or the Graduate College will determine the terms of the student's probation in accordance with the rules of the Graduate College.
- All regular status graduate students must file an approved program before the completion of their third semester. This program must be approved by the student's advisor and the graduate coordinator. All regular and provisional status graduate students must show satisfactory progress towards completion of their degree by completing at least six credits of their approved program per calendar year. If their progress towards their degree program is not satisfactory, students will either be put on probation or expelled from the program.

- Before beginning a dissertation, students must have their dissertation topic approved by their advisor, and the necessary paper work including a dissertation prospectus must be filed with the Graduate College by the end of the third semester. The dissertation prospectus describes the dissertation topic and must include an introductory set of sentences, a well formed hypothesis or hypotheses (specifically italicized in the prospectus) accompanied by a motivation, objectives with major and alternative approaches to the studies, and conjectures of possible outcomes. Students are NOT allowed to take dissertation credits until their prospectus is approved. Credits taken before the approval date will NOT count towards the degree program.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 3 Requirements: Post-Bachelor's Integrated BS-PHD Track

Total Credits Required: 84-93

Course Requirements

Total Credits Required for the Mathematical Sciences M.S.: 30-33

- Required Courses – Credits: 6
    - Complete two of the following courses:
        - MAT 707 - Real Analysis I
        - MAT 709 - Complex Function Theory I
        - MAT 765 - Advanced Numerical Analysis
- Elective Courses – Credits: 21-24
    - Students completing the exam option must complete a minimum of 24 credits of MAT or STA elective courses (excluding MAT 711 & 712), and students completing the thesis option must complete a minimum of 21 credits of MAT or STA elective courses (excluding MAT 711 & 712). Other graduate-level courses may be taken with advisor-approval.
- Thesis – Credits: 6 (Optional)
    - Complete 6 credits from one of the following courses:
        - MAT 791 - Thesis
        - STA 791 - Thesis

Total Credits Required for the Electrical Engineering Ph.D.: 60-66

- Major Field Courses – Credits: 6-15
- Complete 6-15 credits of coursework in an approved major in a single area in Electrical and Computer Engineering with a minimum overall GPA of 3.33.
    - Communications
        - ECG 662 - Advanced Digital Communications
        - ECG 704 - Coding with Applications in Computers and Communication Media

    - ECG 760 - Random Processes in Engineering Problems
    - ECG 762 - Detection and Estimation of Signals in Noise
- Computer Engineering
    - ECG 600 - Computer Communication Networks
    - ECG 603 - Embedded Systems Design
    - ECG 604 - Modern Processor Architecture
    - ECG 605 - Data Compression Systems
    - ECG 607 - Biometrics
    - ECG 608 - Digital Design Verification and Testing
    - ECG 700 - Advanced Computer System Architecture
    - ECG 701 - Reliable Design of Digital Systems
    - ECG 702 - Interconnection Networks for Parallel Processing Applications
    - ECG 704 - Coding with Applications in Computers and Communication Media
    - ECG 706 - Analysis of Telecommunication and Data Networks
    - ECG 707 - Logic Synthesis Engineering
    - ECG 709 - Synthesis and Optimization of Digital Systems
- Control Systems Theory
    - ECG 672 - Digital Control Systems
    - ECG 674 - Recent Topics in Control
    - ECG 770 - Linear Systems Theory
    - ECG 771 - Optimal and Modern Controls
    - ECG 772 - Nonlinear Systems I
    - ECG 774 - Stochastic Control
    - ECG 776 - Adaptive Control
- Electromagnetics and Optics
    - ECG 630 - Transmission Lines
    - ECG 631 - Engineering Optics
    - ECG 632 - Antenna Engineering
    - ECG 633 - Active and Passive Microwave Engineering
    - ECG 730 - Advanced Engineering Electromagnetics I
    - ECG 731 - Theoretical Techniques in Electromagnetics
    - ECG 732 - Advanced Engineering Electromagnetics II
    - ECG 733 - Plasma I
- Electronics
    - ECG 620 - Analog Integrated Circuit Design
    - ECG 621 - Digital Integrated Circuit Design
    - ECG 720 - Advanced Analog IC Design
    - ECG 721 - Memory Circuit Design
    - ECG 722 - Mixed-Signal Circuit Design
- Power Engineering
    - ECG 642 - Power Electronics
    - ECG 646 - Photovoltaic Devices and Systems
    - ECG 740 - Computer Analysis Methods for Power Systems
    - ECG 741 - Electric Power Distribution System Engineering
    - ECG 742 - Power System Stability and Control
- Signal Processing

            - ECG 680 - Discrete-Time Signal Processing
            - ECG 762 - Detection and Estimation of Signals in Noise
            - ECG 781 - Digital Filters
            - ECG 782 - Multidimensional Digital Signal Processing
            - ECG 783 - Adaptive Signal Processing with Neural Networks
        - Solid State Electronics
            - ECG 651 - Electronic and Magnetic Materials and Devices
            - ECG 652 - Optoelectronics
            - ECG 653 - Introduction to Nanotechnology
            - ECG 750 - Optical Electronics I
            - ECG 752 - Physical Electronics
            - ECG 753 - Advanced Topics in Semiconductor Devices I
            - ECG 755 - Monolithic Integrated Circuit Fabrication
            - ECG 756 - Advanced Topics in Semiconductor Devices II
            - ECG 757 - Electron Transport Phenomena in Solid State Devices
- Minor Fields Courses – Credits: 9-18
    - Select two advisor-approved minor fields and complete coursework in each single area totaling 9-18 credits, with a minimum overall average GPA of 3.33. The secondary minor can be from a field outside Electrical Engineering.
        - Communications
            - ECG 662 - Advanced Digital Communications
            - ECG 704 - Coding with Applications in Computers and Communication Media
            - ECG 760 - Random Processes in Engineering Problems
            - ECG 762 - Detection and Estimation of Signals in Noise
        - Computer Engineering
            - ECG 600 - Computer Communication Networks
            - ECG 603 - Embedded Systems Design
            - ECG 604 - Modern Processor Architecture
            - ECG 605 - Data Compression Systems
            - ECG 607 - Biometrics
            - ECG 608 - Digital Design Verification and Testing
            - ECG 700 - Advanced Computer System Architecture
            - ECG 701 - Reliable Design of Digital Systems
            - ECG 702 - Interconnection Networks for Parallel Processing Applications
            - ECG 704 - Coding with Applications in Computers and Communication Media
            - ECG 706 - Analysis of Telecommunication and Data Networks
            - ECG 707 - Logic Synthesis Engineering
            - ECG 709 - Synthesis and Optimization of Digital Systems
        - Control Systems Theory
            - ECG 770 - Linear Systems Theory
            - ECG 771 - Optimal and Modern Controls
            - ECG 772 - Nonlinear Systems I
        - Electromagnetics and Optics
            - ECG 630 - Transmission Lines
            - ECG 631 - Engineering Optics
            - ECG 632 - Antenna Engineering
            - ECG 633 - Active and Passive Microwave Engineering

        - ECG 730 - Advanced Engineering Electromagnetics I
        - ECG 731 - Theoretical Techniques in Electromagnetics
        - ECG 732 - Advanced Engineering Electromagnetics II
        - ECG 733 - Plasma I
    - Electronics
        - ECG 620 - Analog Integrated Circuit Design
        - ECG 621 - Digital Integrated Circuit Design
        - ECG 720 - Advanced Analog IC Design
        - ECG 721 - Memory Circuit Design
        - ECG 722 - Mixed-Signal Circuit Design
    - Power Engineering
        - ECG 642 - Power Electronics
        - ECG 646 - Photovoltaic Devices and Systems
        - ECG 740 - Computer Analysis Methods for Power Systems
        - ECG 741 - Electric Power Distribution System Engineering
        - ECG 742 - Power System Stability and Control
    - Signal Processing
        - ECG 680 - Discrete-Time Signal Processing
        - ECG 762 - Detection and Estimation of Signals in Noise
        - ECG 781 - Digital Filters
    - Solid State Electronics
        - ECG 651 - Electronic and Magnetic Materials and Devices
        - ECG 652 - Optoelectronics
        - ECG 653 - Introduction to Nanotechnology
        - ECG 750 - Optical Electronics I
        - ECG 752 - Physical Electronics
        - ECG 753 - Advanced Topics in Semiconductor Devices I
        - ECG 755 - Monolithic Integrated Circuit Fabrication
        - ECG 756 - Advanced Topics in Semiconductor Devices II
        - ECG 757 - Electron Transport Phenomena in Solid State Devices
- Elective Courses – Credits: 9-18
    - Complete 9-18 credits of 600- or 700-level MAT, PHY, AST, CEE, CEM, ECG, EGG, CS, ME, or other advisor-approved courses.
- Dissertation – Credits: 18
    - ECG 799 - Dissertation

Total Credits Shared: 6

- Two courses can be double counted between Electrical Engineering Ph.D. and Mathematical Sciences M.S. degrees. Non-ECG courses must be applied towards non-ECG elective credits in the electrical engineering degree program pursued.

Degree Requirements

- A minimum of 84, 87, 90, or 93 credits (including thesis and dissertation credits) of graduate work is required for the Dual Electrical Engineering Ph.D. and Mathematical Sciences M.S. which corresponds to the choice of completing a Mathematics comprehensive exam or thesis, and the number of credits of formally approved graduate level courses applied toward the B.S. degree and used in the Electrical Engineering Integrated BS-PHD Track.
- Two of the courses included in the degree program can be double counted Electrical Engineering M.S.E and Mathematical Sciences M.S. degrees. Non-ECG courses must be applied towards non-ECG elective credits in the electrical engineering degree program pursued.

Mathematical Sciences M.S

- Students completing a thesis must complete a minimum of 33 credit hours with a minimum GPA of 3.00.
- Students completing the comprehensive exam must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
- 21 credits of mathematics course work must be at the 700-level (excluding thesis).
- A student will be placed on academic probation if a minimum of 3.00 GPA is not maintained in all work taken in the degree program. A grade of C or less in one graduate-level course will cause a student to be placed on academic probation and will elicit a critical review of the student's program by the Graduate Studies Committee.
- The Graduate College requires a minimum of 50 percent of the total credits required to complete the graduate degree, exclusive of transferred credits and/or the thesis, must be earned at UNLV after admission to a graduate degree program.
- Students must complete a final examination. This will be either an examination to defend the thesis or a written comprehensive examination based on requirements 1 and 2.
- If the thesis option is chosen: In consultation with his/her advisor, a student will organize a dissertation committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.

Electrical Engineering Ph.D.

- All Ph.D. students must satisfy the Ph.D. degree program admission requirements and be admitted to the Ph.D. program on a regular status.
- Total credits required depends on the total number of approved graduate-level course work taken as technical electives (with a grade of B or better) during the senior year.
- Complete a minimum of 60, 63, or 66 credits (including dissertation credits) respectively corresponding to 9, 6, or 3 credits of formally approved graduate level courses applied toward the B.S. degree yielding a total of 69 course credits. The final division of major, minor, and elective credits will be determined in consultation with the student's advisor.
- Of the 69 required credits, a minimum of 33 credits must be in 700-level courses. Of these 33 credits, a minimum of 30 must be from formal courses. The student's doctoral advisory committee may add more requirements in accordance with the individual's background and field of study.

- No more than 6 credits may be from Graduate Independent Study together with Graduate Seminar. No more than 12 credits of a combination of informal courses such as Graduate Independent Study, Special Topics, and Seminar may be applied to the degree program.
- Complete a minimum of 15 credits in an approved ECE major field, 9 credits an approved ECE minor (primary minor) field, and 9 credits in a second approved open minor (secondary minor) field. Of the 15 credits required in the ECE major field, a minimum of 9 credits must be completed in 700-level courses. A minimum GPA of 3.33 (B+=3.30) must be obtained in the major field. Of the 9 required credits in each minor field, a minimum of 6 credits must be in 700-level courses. A minimum GPA of 3.33 (B+=3.30) must be obtained in each of the minor fields.
- Informal courses (Graduate Independent Study, Graduate Seminar, and Special Topics) cannot be applied to the ECE major, ECE minor (primary minor) and the open minor (secondary minor) fields.
- All regular (full graduate standing) status graduate students must select a faculty advisor in their first semester.
- Students on academic probation may be transferred to the M.S.E. Program depending on the student's academic record. In such a case, the M.S.E. Program requirements must be satisfied. For example, only 6 credits of the informal courses may be applied to the M.S.E. degree program with the further constraint that up to 3 credits total of Independent Study in combination with Graduate Seminar may be in the 6 credits.
- Maintain a minimum overall grade point average (GPA) of 3.20, must maintain a minimum GPA of 3.20 each semester, and must complete all graduate level courses that apply towards their degree with a minimum GPA of 2.70 (B-) in each course. Grades below B- cannot be applied towards the Ph.D. degree and must be repeated or replaced. A class grade below C (2.0) is grounds for initiating a program separation recommendation to the Graduate College. Ph.D. candidates who do not maintain an overall minimum GPA of 3.20, who do not maintain a GPA of 3.20 each semester, or who earn more than one grade below B- will either be placed on probation or expelled from the program. The Electrical and Computer Engineering Graduate Committee and/or the Graduate College will determine the terms of the student's probation in accordance with the rules of the Graduate College.
- All regular status graduate students must file an approved program before the completion of their third semester. This program must be approved by the student's advisor and the graduate coordinator. All regular and provisional status graduate students must show satisfactory progress towards completion of their degree by completing at least six credits of their approved program per calendar year. If their progress towards their degree program is not satisfactory, students will either be put on probation or expelled from the program.
- Before beginning a dissertation, students must have their dissertation topic approved by their advisor, and the necessary paper work including a dissertation prospectus must be filed with the Graduate College by the end of the third semester. The dissertation prospectus describes the dissertation topic and must include an introductory set of sentences, a well formed hypothesis or hypotheses (specifically italicized in the prospectus) accompanied by a motivation, objectives with major and alternative approaches to the studies, and conjectures of possible outcomes. Students are NOT allowed to take dissertation credits until their prospectus is approved. Credits taken before the approval date will NOT count towards the degree program.

Graduation Requirements

See Plan Graduation Requirements below.

Plan Graduation Requirements

- Students cannot graduate from one portion of the dual degree until the requirements for both are met. Students must apply to graduate from both programs for the same semester.
- The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.

Mathematical Sciences M.S

- The student must successfully complete a culminating experience.
- If the exam option is chosen, the student must successfully pass a final comprehensive examination.
- If the thesis option is chosen, the student must:
- Submit and successfully defend his/her thesis by the posted deadline. The defense must be advertised and is open to the public.
- Submit his/her approved, properly formatted hard-copy thesis to the Graduate College, and submit the approved electronic version to ProQuest by the posted deadline.

Electrical Engineering Ph.D.

- During the first semester, a Ph.D. student must select a faculty advisor. The faculty advisor does not have to be the one to whom the student was assigned upon entering the Ph.D. program. In coordination with the faculty advisor, the student must also form a doctoral advisory committee. A doctoral advisory committee is composed of at least four members of the UNLV Graduate Faculty. Three of the faculty must be from the Department of Electrical and Computer Engineering. The fourth from a relevant supporting field having Full Graduate Faculty Status as recognized by the Graduate College.
- Students admitted on provisional and/or conditional status are not allowed to take the qualifying exam until their provisions and/or conditions have been met. Students taking the exam while on provisional or conditional status will be required to retake the exam regardless if one or all areas of the exam have been passed.
- Provisional status students must complete all required supplementary work within one calendar year from the time of admission into the program with a grade of B (3.0) or better in each course.
- Pass the Qualifying Exam within 2 semesters of being admitted to the Ph.D. program on a regular (full graduate standing) status. The Qualifying Exam is offered once every fall semester and once every spring semester. This exam cannot be taken more than twice.
- The Qualifying Exam tests the student's general undergraduate knowledge of electrical engineering and computer engineering. To register for the Qualifying Exam, eligible students must notify the graduate coordinator no later than one month prior to the examination date.
- All students must pass the Qualifying Exam within the first two semesters (excluding the summer semester) upon being admitted to the Ph.D. program on a regular status. If a student is required to take the qualifying exam and is not present to sit the exam, an automatic FAIL is assigned. Students who have not passed the Qualifying Exam within this timeframe will be terminated from the Ph.D. program. Students who have not passed the Qualifying Exam by their second attempt will be terminated from the Ph.D. program. Students in the Direct Ph.D. program who fail the Qualifying Exam on their second attempt within the two semester timeframe may elect to pursue a M.S. Degree by completing all of the requirements listed for that degree.
- The Qualifying Exam is a four and one-half hour exam covering questions in the following undergraduate electrical and computer engineering fields:
    - Communications
    - Control System Theory

    - Electromagnetics and Optics
    - Electronics
    - Power
    - Signal Processing
    - Solid State
    - Digital Logic Design
    - Computer Architectures and Organization
    - Digital Electronics and VLSI Design
    - Computer Communication Networks
- To pass the qualifying exam requirement, the student must successfully complete any four of the eleven areas with a grade of PASS to complete the qualifying exam requirement within two sittings. If the student passes less than four areas on the first attempt, the student will receive a PASS for those individual areas successfully completed and will not be required to retake these areas on the second attempt. The exam is a closed note, closed book exam.
- For more details on course specifics, exam logistics, appeal rights and procedure, and protocols regarding the qualifying exam, refer to the ECE department's Electrical Engineering Graduate Program Document.
- In all Post-Bachelor's Tracks, a Ph.D. student must complete a minimum of 15 credits in an approved ECE major field in a single area of Electrical and Computer Engineering, 9 credits in an approved ECE minor field (primary minor) in a single but different area of Electrical and Computer Engineering, and another 9 credits in a second approved minor (secondary minor) field. Currently, the Department of Electrical and Computer Engineering at UNLV offers Communications, Computer Engineering, Control System Theory, Electromagnetics and Optics, Electronics, Power Systems, Signal Processing, and Solid State Materials and Devices as major fields. Specific courses that can be applied to specific fields are listed in detail in the Electrical Engineering Graduate Program Document.
- Of the 15 credits required in the ECE major field, a minimum of 9 credits must be completed in 700-level courses. To complete the ECE major field requirement, the applied 15 credits of ECE major course work must attain a minimum overall GPA of 3.33 (B+=3.30).
- Each student must complete two minor fields. To complete a minor field, a student must complete a minimum of 9 credits in a minor field and have an overall minimum GPA of 3.33 (B+=3.30) for the 9 minor field credits. Of the 9 required credits in each minor field, a minimum of 6 credits must be in 700-level courses. Courses that can be applied to specific minor fields are listed in detail in the Electrical Engineering Graduate Program Document. These courses may be applied to any designated field but may only be counted once. With the written approval of the major advisor and the student's advisory committee, the secondary minor may be a mixed minor field. A mixed minor field may be formed with courses inside and/or outside of the Electrical Engineering Department's approved fields (e.g., mathematics and physics, computer engineering and computer science, physics, mechanical engineering, solid state and electromagnetics) A mixed minor may not be composed of courses in the Electrical Engineering Department that satisfy course work in the major and the other minor field. The only exception is when a course may be used in more than one field. In this case, the course may not be counted twice but may be used for either minor area. However, the student must complete at least one minor field (primary minor field) in Electrical Engineering in a single area.
- After passing the Qualifying Exam, successfully completing all courses for a major field, and successfully completing all courses for the ECE minor field, students are eligible to take the Comprehensive Exam. All students must have passed the Comprehensive Exam within two semesters after successfully completing all required course work except for the 18 credits Dissertation. [NOTE: Up to 6 credits of Dissertation taken prior to the successful completion of the Preliminary Exam may

count towards the degree program.] The Comprehensive Exam cannot be taken more than once per semester and cannot be taken more than twice.

- The Comprehensive Exam tests the candidate's depth of knowledge in the candidate's chosen ECE major field and chosen ECE minor (primary minor) field. All students must have passed the Comprehensive Exam within two semesters after successfully completing all required course work (except for the 18 credits of Dissertation). The Comprehensive Exam is offered once every fall semester and once every spring semester. The Comprehensive Exam cannot be taken more than twice. Candidates who have not passed the Comprehensive Exam within this timeframe (two consecutive sittings) will be terminated from the Ph.D. program. Candidates who have not passed the Comprehensive Exam following their second attempt will be terminated from the Ph.D. program.
- Before a student is eligible to register for the Comprehensive Exam, the candidate must have obtained regular (full graduate standing) admission status, passed the Qualifying Exam, and must have successfully completed all of the course requirements for the ECE major field and the ECE minor (primary minor) field. The student must have acquired a minimum GPA of 3.33 in both the major and minor fields separately. If the minor field GPA is less than 3.33 and/or the major field GPA is less than 3.33, then the minor and/or minor field requirement has not been successfully completed. The candidate will not be allowed to take the Comprehensive Exam until both the major and minor 3.33 GPA requirements are fulfilled. Further, the student must have a minimum overall GPA of 3.2 and must have satisfied all other Ph.D. degree program admission requirements. If a student takes the Comprehensive Exam before any one of these requirements has been satisfied, the student will automatically receive a FAIL grade for the exam. At their discretion, the Graduate Committee may also count this failing grade as one of the student's attempts for the Comprehensive Exam. To register for the Comprehensive Exam, eligible students must notify the graduate coordinator no later than one month prior to the examination date.
- To pass the Comprehensive Exam, a student must pass a five-hour exam covering courses in his/her ECE major field and ECE minor (primary minor) field. A pass or fail grade will be given for the exam. The graduate committee will notify students of the results of the exam. The major and minor area exam will emphasize graduate coursework taken in the ECE major and ECE minor (primary minor; minor 1) fields. The exam will evaluate the student's ability to apply his/her theoretical and analytical abilities to problems in his/her ECE major and ECE minor (primary minor) field. However, the exam may require knowledge of undergraduate material related to the student's major and minor fields. Students should expect problems that require advanced thinking. Specific problems need not be familiar textbook problems nor may the student be necessarily familiar with the problem. A pass or fail grade will be given for the exam. The graduate committee will notify students of the exam results.
- For more details on course specifics, exam logistics, appeal rights and procedure, and protocols regarding the comprehensive exam, refer to the ECE department's Electrical Engineering Graduate Program Document.
- After successfully completing all required course work and passing the Comprehensive Exam, the candidate must pass the Preliminary Exam. The Preliminary Exam cannot be taken more than once per semester but may be repeated until passed.
- The Preliminary Exam evaluates the caliber of a student's dissertation topic. The Preliminary Exam cannot be taken more than once per semester but may be repeated until passed.
- To be eligible for the Preliminary Exam, a student must have passed the Comprehensive Exam, and have successfully completed all required course work except for the 18 credits of Dissertation.
- Before the Preliminary Exam, a student must prepare a 10 to 20-page prospectus of his/her research. A copy of this prospectus must be submitted to the Graduate Committee and each member of the Ph.D. candidate's advisory committee at least two weeks prior to the Preliminary Exam.

- The student must also notify the Graduate Committee and each member of their advisory committee of the date, time and location of their Preliminary Exam. This must be done at least two weeks prior to the Preliminary Exam.
- During the Preliminary Exam, the student presents his/her prospectus to his advisory committee. To pass the Preliminary Exam, the student's advisory committee must unanimously approve the student's prospectus. Students who pass the Preliminary Exam are advanced to candidacy for the Ph.D.
- Complete a minimum of 18 credits of Dissertation and complete a dissertation containing original research. Upon completion, the student must pass the Final Exam in which the student defends his/her dissertation. The Final Exam is the culminating experience of the PhD program.
- The Final Exam evaluates the Ph.D. candidate's dissertation. The Final Exam cannot be taken more than once per every three months but may be repeated until passed. To be eligible for the Final Exam, a Ph.D. candidate must have passed the Preliminary Exam, and have successfully completed all required course work including a minimum of 18 credits of Dissertation. A minimum of 12 credits of Dissertation must be taken after the successful completion of the Preliminary Exam. A copy of the Ph.D. candidate's dissertation must be submitted to the Graduate Committee and each member of the Ph.D. candidate's advisory committee at least two weeks prior to the Final Exam. The Ph.D. candidate must also notify the Graduate Committee and each member of his/her advisory committee of the date, time, and location of his/her Final Exam at least two weeks prior to the Final Exam. During the Final Exam, the Ph.D. candidate will present his/her dissertation to their advisory committee. To pass the Final Exam, the Ph.D. candidate's advisory committee must unanimously approve the Ph.D. candidate's dissertation.
- The Department of Electrical and Computer Engineering requires that the Ph.D. degree be completed within a period of six years from the time the candidate is fully admitted to the Ph.D. program. Further, courses taken more than six years prior to graduation cannot be applied toward the PhD degree without permission from the Graduate College. Students exceeding this time limit must formally write a letter requesting permission from both the Graduate Committee and the Graduate College to stay in the Ph.D. program and apply coursework towards the degree program. The formal letter must explain the circumstances of why the degree was not completed within the allotted timeframe and indicate the extended period of time needed to complete the degree.
- The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
- The student must submit and successfully defend his/her dissertation by the posted deadline. The defense must be advertised and is open to the public.
- Student must submit his/her approved, properly formatted hard-copy dissertation to the Graduate College, and submit the approved electronic version to ProQuest by the posted deadline.

Mathematical Sciences Courses

MAT 651 - Foundations of Mathematics I

This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 652 - Foundations of Mathematics II

This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings

and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 653 - Abstract Algebra I
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 654 - Abstract Algebra II
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 655 - Elementary Theory of Numbers I
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 656 - Elementary Theory of Numbers II
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 657 - Introduction to Real Analysis I
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 658 - Introduction to Real Analysis II
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the

corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 659 - Elementary Complex Analysis
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 661 - Probability Theory
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 662 - Stochastic Processes
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 663 - Advanced Matrix Theory and Applications
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 665 - Numerical Analysis I
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 666 - Numerical Analysis II
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate

credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 668 - Applied Finite Element Analysis
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 669 - Combinatorics I
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 670 - Combinatorics II
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 680 - College Geometry
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 683 - General Topology I
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 684 - General Topology II
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in

an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 687 - Introduction to Partial Differential Equations
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 689 - Advanced Mathematical Topics
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 690 - Independent Study
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

MAT 701 - Foundations of Mathematics III
Credits 3
Selection from the following topics: model theory, recursive function theory, set theory, mathematics of metamathematics. **Prerequisites** MAT 652

MAT 702 - Foundations of Mathematics IV
Credits 3
Selection from the following topics: model theory, recursive function theory, set theory, mathematics of metamathematics. **Prerequisites** MAT 652

MAT 703 - Abstract Algebra III
Credits 3
Detailed study of the following algebraic structures: groups, rings and ideals, fields, modules, and Galois theory. **Prerequisites** A year of undergraduate abstract algebra or consent of instructor.

MAT 704 - Abstract Algebra IV
Credits 3
Detailed study of the following algebraic structures: groups, rings and ideals, fields, modules, and Galois theory. **Prerequisites** A year of undergraduate abstract algebra or consent of instructor.

MAT 707 - Real Analysis I
Credits 3

Theory of measure, integration and differentiation: Banach spaces; Hilbert spaces; spaces of continuous functions. **Prerequisites** MAT 658

MAT 708 - Real Analysis II
Credits 3
Theory of measure, integration and differentiation: Banach spaces; Hilbert spaces; spaces of continuous functions. **Prerequisites** MAT 658

MAT 709 - Complex Function Theory I
Credits 3
Analytic functions, conformal mappings, Cauchy's theorem, power series, Laurent series, the Riemann mapping theorem, harmonic functions, subharmonic functions, canonical mappings of multiply connected regions, analytic continuation. **Prerequisites** MAT 657 or MAT 659 or equivalent.

MAT 710 - Complex Function Theory II
Credits 3
Analytic functions, conformal mappings, Cauchy's theorem, power series, Laurent series, the Riemann mapping theorem, harmonic functions, subharmonic functions, canonical mappings of multiply connected regions, analytic continuation. **Prerequisites** MAT 657 or MAT 659 or equivalent.

MAT 711 - Survey of Mathematical Problems I
Credits 3
Selected topics from logical reasoning, probability, combinatorics, graph theory, codes, number theory, constructibility, game theory, limits, functions, set theory and foundations, and plane geometry. Problem solving and techniques of proof emphasized throughout. Connections made between the mathematics of this course and secondary education mathematics. **Prerequisites** Graduate standing and consent of instructor.

MAT 712 - Survey of Mathematical Problems II
Credits 3
Continuation of topics listed for MAT 711 with emphasis on problem solving and techniques of proof. Again, connections made between the mathematical content of this course and mathematical content for secondary education. **Prerequisites** MAT 711 or consent of instructor.

MAT 714 - History of Mathematics
Credits 3
Historical development of mathematics from primitive origins to the present time. Lives of many mathematicians and their contributions to the development of mathematics. **Prerequisites** Graduate standing and consent of instructor.

MAT 716 - Integrative Mathematical Topics
Credits 3
Survey of mathematical topics in an integrative manner. The topics may cover theory and applications in long stretches including probability and statistics; combinatorics, number theory and algebra; geometry and topology; ODE and PDE; computation and numerical analysis; Real and complex analysis. **Prerequisites** At least nine credits at 600-level as required in Requirement #1.

MAT 717 - Analytical Solution Methods for Partial Differential Equations, I
Credits 3
Covers the basic theory and methods for solving linear partial differential equations. Emphasis on introducing

various techniques to obtain analytical solutions of linear partial differential equations. Techniques include: Method of separation of variables; Fourier transform method; Laplace transform method; Green's function method, etc. **Prerequisites** MAT 487/687, or MAT 458/658, or consent of instructor.

MAT 718 - Analytical Solution Methods for Partial Differential Equations, II
Credits 3
Covers the basic theory and methods for solving nonlinear partial differential equations. Emphasise on introducing various techniques to obtain analytical solutions. Techniques include: Generalized method of characteristics, method of shock wave solution, method of travelling wave solution, perturbation method, method of similarity solution, etc. **Prerequisites** MAT 487/687, or MAT 717, or consent of instructor.

MAT 723 - Advanced Ordinary Differential Equations I
Credits 3
Functional analysis; Frechet calculus; existence and uniqueness theorems for initial and boundary value problems; qualitative properties of solutions, particularly of linear equations. **Prerequisites** MAT 671–672 or MAT 673–674

MAT 724 - Advanced Ordinary Differential Equations II
Credits 3
Topics to be selected from the following: Sturm-Liouville theory, stability theory, perturbation theory, numerical methods, the theory of invariant imbedding and functional differential equations. **Prerequisites** MAT 723

MAT 725 - Mathematics for Operations Research I
Credits 3
Theory of stochastic processes, theory of queues, Markov processes, non-Markov processes, Markov chains, applications. **Prerequisites** MAT 661

MAT 726 - Mathematics for Operations Research II
Credits 3
Linear and non-linear programming, dynamic programming, Lagrange multiplier and duality theorems, control theory and optimal control, applications of programming. **Prerequisites** MAT 671 and 673

MAT 729 - Partial Differential Equations I
Credits 3
Linear and nonlinear first order PDEs. Heat, wave and Laplace equations. Classical representation formulas in one and more dimensions. Properties of solutions: maximum principles, energy methods, uniqueness and regularity considerations. **Prerequisites** MAT 687 or MAT 717

MAT 730 - Partial Differential Equations II
Credits 3
Develops a functional analytical framework which will give students a deeper understanding of the subject matter. Topics include Sobolev and Holder spaces, embedding inequalities, weak solutions, regularity and maximum principles. **Prerequisites** MAT 708 and MAT 729, or consent of instructor.

MAT 731 - Mathematical Modeling
Credits 3
Process and techniques of mathematical modeling with an emphasis on differential equations based models, though other models may also be considered. Applications selected from physical, biological and social sciences. Modeling projects based on student interests. Symbolic computation software. **Prerequisites** MAT 687 or MAT 717 or consent of instructor.

MAT 733 - Topology
Credits 3
Selected topics from algebraic and point-set topology with emphasis on algebraic topology. **Prerequisites** MAT 684 or consent of instructor.

MAT 734 - Topology
Credits 3
Selected topics from algebraic and point-set topology with emphasis on algebraic topology. **Prerequisites** MAT 684 or consent of instructor.

MAT 740 - Mathematical Wave Propagation Theory and Application I
Credits 3
Review of linear wave equations, techniques of linear and non-linear modeling of natural occurrences and their role in understanding mathematical inversion, mathematical foundation of dyadic wave propagation, introduction to asymptotic analysis and boundary layer theory, application to problems for waves propagating in the atmosphere, ocean and space. **Prerequisites** MAT 717 or MAT 729 or consent of instructor.

MAT 741 - Mathematical Wave Propagation Theory and Application II
Credits 3
The generalized tensor wave nature of matter, advanced mathematical methods of non-linear and quantum optics. Earth quake dynamics, elastic waves and cracks propagation with applications from earth system and space science. **Prerequisites** MAT 718 and MAT 740 or consent of instructor.

MAT 751 - Topics in Foundations of Mathematics
Credits 3. **Notes** May be repeated for credit with the consent of the mathematics department. Except under special circumstances, total credits limited to six credits. **Prerequisites** MAT 701–702

MAT 753 - Homological Algebra
Credits 3
Modules, categories and factors, tensors, Hom, Tor, Ext, the dimensions of rings and modules, derived factors, cohomology of groups and algebras. **Prerequisites** MAT 703–704 or consent of instructor.

MAT 754 - Homological Algebra
Credits 3
Modules, categories and factors, tensors, Hom, Tor, Ext, the dimensions of rings and modules, derived factors, cohomology of groups and algebras. **Prerequisites** MAT 703–704 or consent of instructor.

MAT 755 - Topics in Algebra
Credits 3. **Notes** May be repeated for credit with the consent of the mathematics department. Except under special circumstances, total credits limited to six. **Prerequisites** MAT 703–704 or consent of instructor.

MAT 756 - Arithmetic on Elliptic Curves
Credits 3
The group structure of elliptic curves over the reals, complex numbers, the rationals, number fields, and finite fields; Bezout's theorem and its applications; projective geometry; genus; Mordell's theorem; points of finite order; and heights. Additional topics may include complex multiplication; modular forms; and factoring using elliptic curves. **Prerequisites** MAT 653 and 654, or equivalent.

MAT 757 - Topics in Analysis
Credits 3. **Notes** May be repeated for credit with the consent of the mathematics department. Except under special circumstances, total credits limited to six. **Prerequisites** MAT 707–708 or consent of instructor.

MAT 760 - Mathematical Scattering Theory and Applications I
Credits 3
Scalar, vector, and tensor scattering with diverse techniques applied to earth system and space science. General Reciprocity Relations Corresponding to Different Directions of Incidence, Dyadic Scattering Theory, Two-Space Scattering Formalism of Victor Twersky, and Applications to Earth and Space Related Problems. **Prerequisites** MAT 717 or MAT 729 or consent of instructor.

MAT 761 - Mathematical Scattering Theory and Applications II
Credits 3
Advanced statistical mechanics and spatial statistics in relation to Twersky scattering with applications from earth system and space science. Calculation of bulk propagation parameters using both configurational and ensemble average in addition to spatial average. Application of Twersky multiple two-Space Scattering formalism to space and earth related problems. **Prerequisites** MAT 760 or consent of instructor.

MAT 765 - Advanced Numerical Analysis
Credits 3
Numerical solution of ordinary and partial differential equations; advanced programming techniques; experiments with the computer. **Notes** Topics selected by instructor.Three hours lecture, two hours laboratory. **Prerequisites** MAT 666

MAT 766 - Advanced Numerical Analysis
Credits 3
Numerical solution of ordinary and partial differential equations; advanced programming techniques; experiments with the computer. **Notes** Topics selected by instructor. Three hours lecture, two hours laboratory. **Prerequisites** MAT 666

MAT 767 - Topics in Numerical Analysis
Credits 3
Topics selected by the instructor. **Notes** May be repeated for credit with the consent of the mathematics department. Except under special circumstances, total credits limited to six. **Prerequisites** MAT 765–766

MAT 771 - Applied Analysis I
Credits 3
Functional analysis in Banach spaces and Hilbert spaces, with emphasis on computational applications. Theoretical topics to be selected from: linear functionals and operators, fixed point theorems, iterative methods, elementary spectral theory. Applications to be selected from: finite element methods, finite difference methods, approximation and interpolation, optimization algorithms. **Prerequisites** Graduate standing and consent of instructor.

MAT 772 - Applied Analysis II
Credits 3
Functional analysis in Banach spaces and Hilbert spaces, with emphasis on computational applications. Theoretical topics to be selected from: linear functionals and operators, fixed point theorems, iterative methods, elementary spectral theory. Applications to be selected from: finite element methods, finite difference methods, approximation and interpolation, optimization algorithms. **Prerequisites** Graduate standing and consent of instructor.

MAT 775 - Calculus of Variations
Credits 3
Variation of functionals, Euler-Lagrange equation, general variations, broken extremals, Weierstrass-Erdmann conditions, canonical forms, Noether's theorem, Hamilton- Jacobi equations, Legendre's condition, conjugate points, fields, E-function, sufficient conditions for extrema, Pontryagin's principle, introduction to linear and non-linear optimal control theory. **Prerequisites** MATH 428 or 658 or consent of instructor.

MAT 777 - Application of High-Performance Computing Methods in Science and Engineering
Credits 3
Application of high performance computing systems to science and engineering, models for numerically intensive problem solving, high performance numerical algorithms, FORTRAN 90 and high-performance FORTRAN. **Same as** (ME 777). **Prerequisites** Knowledge of UNIX, FORTRAN, and previous course on numerical methods. Graduate standing.

MAT 783 - Topics in Topology
Credits 3. **Notes** May be repeated for credit with the consent of the mathematics department. Except under special circumstances, total credits limited to six credits. **Prerequisites** Consent of instructor.

MAT 789 - Topics in Advanced Mathematics
Credits 3
Graduate-level course in some field of mathematics, at advanced level, depending upon the current interest of the staff and the students. **Notes** May be repeated to a maximum of six credits.

MAT 790 - Independent Study
Credits 1–3
Library work and reports on topics of mathematical interest. **Notes** May be repeated for credit with the consent of the mathematics department. Except under special circumstances, total credits will be limited to six.

MAT 791 - Thesis
Credits 1–6. **Notes** May be repeated but only six credits will be applied to the student's program. **Grading** S/F grading only.

MAT 792 - Research Seminar
Credits 1
Oral presentation of assigned articles. **Notes** May be repeated to a maximum of four credits.

MAT 793 - Teaching Concentration Professional Paper Research
Credits 1–3
Individual research towards an applied professional paper under the direction of a faculty member. **Notes** May be repeated any number of times, but no more than three credits will count towards degree requirements. **Grading** S/F grading only. **Prerequisites** Consent of instructor.

MAT 799 - Dissertation
Credits 3–6
Research analysis and writing toward completion of dissertation and subsequent defense. A minimum of 24 dissertation credits is required for a degree program. Dissertation may be repeated buy only a maximum of 36 credits may be used in students degree program. **Grading** S/F grading only. **Prerequisites** Successful completion of qualifying examination and approval by department.

STA 663 - Applied Statistics for Engineers
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

STA 667 - Introduction to Mathematical Statistics
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

STA 669 - Environmental Statistics I: Univariate Methods
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

STA 689 - Advanced Statistics Topics
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program.

STA 690 - Independent Study
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program. This course offered by another department may also be taken for graduate credit.

STA 691 - Statistics for Scientists I
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program. This course offered by another department may also be taken for graduate credit.

STA 692 - Statistics for Scientists II

This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program. This course offered by another department may also be taken for graduate credit.

STA 693 - Applied Regression Analysis
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program. This course offered by another department may also be taken for graduate credit.

STA 695 - Nonparametic Statistics
This course, when taught by a member of the graduate faculty, may be applied to a graduate program. For listings and a course description of this 600-level course, please consult the current Undergraduate Catalog under the corresponding 400 number. **Notes** The 600-level MAT and STA courses that are normally available for graduate credit are those numbered 650 or higher; the exceptions are MAT 680, which may be counted for graduate credit in an education degree program, and STA 691, STA 693, and STA 695, which may be counted for graduate credit in a biological sciences program. This course offered by another department may also be taken for graduate credit.

STA 713 - Experimental Design
Credits 3
Fundamental principles of analysis of variance; one-way, two-way, and higher order designs; nested designs; randomized blocks; split plot designs; Latin squares; multiple comparisons; analysis of covariance. **Prerequisites** MATH 181 and one of the following: STAT 411, STA 663 and STA 693.

STA 715 - Multivariate Statistical Methods
Credits 3
Multivariate techniques with emphasis on application. Topics include multivariate analysis of variance, discriminant analysis, canonical correlation and independence, principal component analysis, factor analysis, cluster analysis and analysis of repeated measurements. **Prerequisites** MATH 181, MATH 463 and one of the following: STAT 411, STA 663, STA 691.

STA 717 - Environmental Statistics
Credits 3
Testing for multivariate normality, data dependent transformations for multivariate normality, tests for outliers for multivariate data, multivariate control charts, exploratory data analysis of multivariate data using principal components, cluster analysis, factor analysis, and multivariate calibration problems. **Prerequisites** MATH 181 and one of the following: STAT 411, STA 663, STA 691.

STA 731 - Probability Theory and Its Applications
Credits 3
Topics include: set theory, limits of sets, probability space, random variables, measurability, independence, expectation, probability inequalities, convergence, laws of large numbers, central limit theorem, moment generating functions, characteristic functions, large deviation theory, martingale theory, random walk. **Prerequisites** MAT 657

STA 750 - Time Series Analysis
Credits 3
Topics include ARMA and ARIMA processes; autocorrelation and partial autocorrelation functions; spectral density and periodogram; Yule-Walker equations; model fitting, forecasting and diagnostics; state-space models and the Kalman filter; multivariate time series; use of statistical software. **Prerequisites** STA 667 or consent of instructor.

STA 751 - Spatial Statistics
Credits 3
Stochastic process, first and second order stationarity, intrinsic hypothesis, models of spatial dependence, different forms of Kriging â€" Ordinary Kriging, Universal Kriging, Probability Kriging, bicubic splines, conditional simulation. **Prerequisites** STA 667 or consent of instructor.

STA 753 - Bayesian Data Analysis
Credits 3
This course will present methods for statistical modeling and data analysis from a Bayesian perspective. Topics include: Bayes' Theorem, prior and posterior distributions, computational algorithms for posterior simulation, statistical software and programming, as well as model formulation and diagnostics for linear, generalized linear, and hierarchical models. **Prerequisites** STA 667 or equivalent, or consent of instructor.

STA 755 - Stochastic Modeling I
Credits 3
Probability theory, Markov chains in discrete and continuous time, the Poisson process, renewal theory, queueing theory, reliability theory, martingales, stationary processes, statistical inference for stochastic processes, and simulation techniques. **Prerequisites** STA 667 or consent of instructor.

STA 756 - Stochastic Modeling II
Credits 3
Probability theory, Markov chains in discrete and continuous time, the Poisson process, renewal theory, queueing theory, reliability theory, martingales, stationary processes, statistical inference for stochastic process, and simulation techniques. **Prerequisites** STA 755

STA 761 - Regression Analysis I
Credits 3
Fitting a straight line, matrix theory, examining residuals, selecting the "best" fit, multiple regression, non-linear regressions, multivariate normal, estimation, classification, principal components, canonical correlation, distribution of characteristic roots. **Prerequisites** STA 667 and MAT 663, or equivalent.

STA 762 - Regression Analysis II
Credits 3
Fitting a straight line, matrix theory, examining residuals, selecting the "best" fit, multiple regression, non-linear regressions, multivariate normal, estimation, classification, variance-covariance matrix, testing sets of variates, principal components, canonical correlation, distribution of characteristic roots. **Prerequisites** STA 667 and MAT 663 or equivalent.

STA 763 - Analysis of Variance I
Credits 3
Special topics in matrix theory; noncentral chi-square, F, and t; the multivariate normal distribution; Cochran's theorem; point and interval estimation; one-, two-, three-, higher-way layouts; Latin squares, incomplete blocks and nested designs, analysis of covariance; random effects models; mixed models; randomization models. **Prerequisites**

STA 667 and MAT 663 or equivalent.

STA 764 - Analysis of Variance II
Credits 3
Special topics in matrix theory; noncentral chi-square, F, and t; the multivariate normal distribution; Cochran's theorem; point and interval estimation; one-, two-, three-, higher-way layouts; Latin squares, incomplete blocks and nested designs, analysis of covariance; random effects models; mixed models; randomization models. **Prerequisites** STA 667 and MAT 663 or equivalent.

STA 765 - Statistical Decision Theory
Credits 3
Introduction to decision theory, decision rules, loss functions, risk functions, decision principles, utility theory, prior information and subjective probability, noninformative priors, the posterior distribution, conjugate families, predictive distribution, Bayesian estimators, generalized Bayes estimators, credible regions, hypothesis testing, admissibility of Bayes rules, robustness of Bayes rules, minimax analysis, invariance, Bayesian sequential analysis. **Prerequisites** STA 667 or consent of instructor.

STA 767 - Mathematical Statistics I
Credits 3
Basic probability theory, conditional probability, independence, random variables, probability distribution functions, distribution functions, transformations, function of random variables, expectations, moment generating functions, discrete and continuous distributions, exponential family, joint distribution, marginal distribution, modes of convergence, limiting distribution, random sample, sampling distribution, principle of data reduction. **Prerequisites** STA 667 or consent of instructor.

STA 768 - Mathematical Statistics II
Credits 3
Random sample, sampling theory, point estimation, sufficiency, likelihood, method of moment, maximum likelihood estimator, Bayes estimator, unbiasedness, optimality, decision theory, hypothesis testing, likelihood ratio tests, Bayes test, most powerful test, set estimation, evaluating interval estimators, sequential estimation, asymptotics, robustness, linear models. **Prerequisites** STA 767

STA 789 - Topics in Advanced Statistics
Credits 3
Graduate-level course in some field of statistics, depending upon the current interest of the faculty and the students. **Notes** May be repeated to a maximum of six credits.

STA 790 - Independent Study
Credits 1–3
Library research and reports on topics of statistical interest. **Notes** May be repeated to a maximum of six credits with consent of the department.

STA 791 - Thesis
Credits 3–6. **Notes** May be repeated but only six credits applied to the student's program. **Grading** S/F grading only.

STA 792 - Research Seminar
Credits 1
Oral presentation of assigned articles. **Notes** May be repeated to a maximum of four credits.

STA 793 - Techniques of Statistical Consulting
Credits 1–3
Seminar series and practicum covering technical and nontechnical aspects of statistical consulting, including skills for effective communication with clients, report writing, issues in sampling and design of experiments, and other statistical tools commonly used in a consulting setting. **Notes** May be repeated to a maximum of six credits.

STA 799 - Dissertation
Credits 3–6
Research analysis and writing toward completion of dissertation and subsequent defense. A minimum of 24 dissertation credits is required for the degree program. Dissertation may be repeated but only a maximum of 36 credits may be used in students degree program. **Prerequisites** Successful completion of qualifying examination and approval by department.

Physics and Astronomy

The Physics Department offers M.S. and Ph.D. degrees in physics, with concentrations in three research areas: laser physics, high pressure physics (in collaboration with LLNL and LANL), and condensed matter physics. The Physics Department also offers M.S. and Ph.D. degrees in Astronomy. The astronomers make use of space telescopes such as the Hubble Space Telescope, Swift, Chandra Xray Observatory and XMM-Newton Observatory, etc. to conduct research. The department's experimental research programs are supported by fully equipped laboratories and mechanical, electronic and glass shops. The department is well equipped with state-of-the-art computing facilities, which allow for performing virtually any modeling and computer simulation.

Stephen Lepp, Ph.D., Chair
Lon Spight, Ph.D., Graduate Coordinator

Chair

Lepp, Stephen - *Full Graduate Faculty*
Professor; B.S., University of Minnesota; M.A., Ph.D., University of Colorado, Boulder. *Rebel since 1991.*

Graduate Coordinator

Spight, Lon D. - *Full Graduate Faculty*
Associate Professor; B.S., M.S., Colorado State University; Ph.D., University of Nevada, Reno. *Rebel since 1970.*

Graduate Faculty

Chen, Changfeng - *Full Graduate Faculty*
Professor; B.S., Ph.D., Peking University. *Rebel since 1990.*

Cornelius, Andrew - *Full Graduate Faculty*
Professor; B.S., Drake University; Ph.D., Washington University. *Rebel since 1999.*

Farley, John W. - *Full Graduate Faculty*
Professor; B.A., Harvard College; M.A., Ph.D., Columbia University. *Rebel since 1987.*

Kwong, Victor H. - *Full Graduate Faculty*
Professor; B.S., Queen's University; M.S., University of Windsor; Ph.D., University of Toronto. *Rebel since 1984.*

Kumar, Ravhi
Associate Research Professor; Ph.D., Anna University, Chennai.
Lepp, Stephen H. - *Full Graduate Faculty*
Professor; B.S., University of Minnesota; M.A., Ph.D., University of Colorado, Boulder. *Rebel since 1991.*

Nagamine, Kentaro - *Full Graduate Faculty*
Associate Professor; B.S., University of Tokyo; M.A., Ph.D., Princeton University. *Rebel since 2006.*

Pang, Tao - *Full Graduate Faculty*
Professor; B.S., Fudan University; Ph.D., University of Minnesota. *Rebel since 1991.*

Pravica, Michael - *Full Graduate Faculty*
Associate Professor; B.S., Cal Tech; A.M., Ph.D., Harvard University. *Rebel since 2003.*

Proga, Daniel - *Full Graduate Faculty*
Associate Professor; M.S., Nicolaus Copernicus University; Ph.D. Nicolaus Copernicus Astronomical Center. *Rebel since 2005.*

Rhee, George - *Full Graduate Faculty*
Associate Professor; B.A., Cambridge University; M.Sc., Leiden University; M.A., Cambridge University; Ph.D., Leiden University. *Rebel since 1993.*

Selser, James C. - *Full Graduate Faculty*
Professor; B.S., U.S. Air Force Academy; M.S., Ph.D., University of California, Davis. *Rebel since 1981.*

Shelton, David P. - *Full Graduate Faculty*
Professor; B.A., M.S., Ph.D., University of Manitoba. *Rebel since1988.*

Zhang, Bing - *Full Graduate Faculty*
Professor; B.S., M.S., Ph.D., Peking University. *Rebel since 2004.*

Zhao, Yusheng - *Full Graduate Faculty*
Professor; B.S., M.S., Peking University; Ph.D., University of California, Berkely. *Rebel since 2010.*

Zygelman, Bernard - *Full Graduate Faculty*
Professor; B.S., Ph.D., City College of New York. *Rebel since 1990.*

Professor Emeritus

Cloud, Stan
Emeritus Professor; B.S. Stanford University; M.S., Ph.D., Duke University. *UNLV Emeritus 1980-2005.*

Pyper-Smith, Diane - *Full Graduate Faculty*
Associate Professor; A.B., University of California, Berkeley; Ph.D., University of California, Santa Cruz. *UNLV Emeritus*

Weistrop, Donna E.
Emeritus Professor; B.A., Wellesley College; Ph.D., California Institute of Technology. *UNLV Emeritus 1990-2005.*

Zane, Len
Emeritus Professor; B.S., City College of New York; Ph.D. Duke University. *UNLV Emeritus 1973-2011.*

Physics & Astronomy Plans

Master of Science - Astronomy

Plan Description

The purpose of the Astronomy M.S. and Ph.D. degrees are to prepare students for a career in Astronomy or Astrophysics Research or in education at the university level. The program achieves this with a custom program for each student set up by their advisor and their advising committee. At the M.S. level we have two options. A coursework M.S., wherein students take classes at the graduate level in Astronomy and pass an exam. We also offer a thesis option where students will learn to formulate, conduct and report on research.

Learning Outcomes

www.unlv.edu/degree/ms-astronomy

Plan Admission Requirements

- Applicants must have an undergraduate degree in Physics, Astronomy or other related area.
- Applicants must have a minimum grade point average (GPA) of 2.75 for all undergraduate work or a minimum 3.00 GPA for the last two years of undergraduate work.
- Applicants must have completed 18 semester credits of upper-division physics.
- All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements.

Plan Requirements

See Subplan Requirements below.

Subplan 1 Requirements: Thesis Track

Total Credits Required: 30

Course Requirements

- Required Courses – Credits: 24
    - Complete 24 credits of 600- or 700-level AST or PHYS courses, or other advisor-approved courses.
- Thesis – Credits: 6
    - PHYS 797 - Thesis

Degree Requirements

- Complete a minimum of 30 graduate credits.
- Complete a minimum of 15 credits (excluding thesis) in 700-level astronomy or physics courses.
- A GPA of 3.00 or better is required in all course work which is part of the degree program.
- In consultation with his/her advisor, a student will organize a thesis committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.

Graduation Requirements

- The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
- The student must successfully complete and defend a thesis by the posted deadline. The defense must be advertised and is open to the public.
- Student must submit his/her approved, properly formatted hard-copy thesis to the Graduate College, and submit the approved electronic version to ProQuest by the posted deadline.

Subplan 2 Requirements: Non-Thesis Track

Total Credits Required: 30

Course Requirements

- Required Courses – Credits: 6
    - AST 713 - Astrophysics I
    - AST 714 - Astrophysics II
- Core Courses – Credits: 6
    - Complete two of the following courses:
        - AST 710 - Observational Astronomy Techniques
        - AST 721 - Astrophysics of Gaseous Nebulae and Active Galactic Nuclei
        - AST 725 - High Energy Astrophysics
        - AST 727 - Cosmology
        - AST 747 - Interstellar Medium
        - PHYS 771 - Advanced Topics in Experimental and Theoretical Physics
- Elective Courses – Credits: 18
    - Complete 18 credits of 600- or 700-level AST or PHYS courses, or other advisor-approved courses.

Degree Requirements

- Complete a minimum of 30 graduate level credits in physics, astronomy, or related fields (excluding graduate seminar).
- Complete at least 15 credits of 700-level astronomy or physics courses.
- A GPA of 3.00 or better in all course work which is part of the degree program.
- In consultation with his/her advisor, a student will organize an advisory committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.
- Satisfactory performance on an astronomy qualifying examination on graduate astronomy knowledge at the master's level.

Graduation Requirements

- The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
- The student must pass a qualifying examination.

Plan Graduation Requirements

Refer to your subplan for Graduation Requirements.

- Subplan 1: Thesis Track
- Subplan 2: Non-Thesis Track

Master of Science - Physics

Plan Description

The purpose of the Physics M.S. and Ph.D. degrees are to prepare students for a career in Physics Research or in education at the university level. The program achieves this with a custom program for each student set up by their advisor and their advising committee. At the M.S. level students will learn to formulate, conduct and report on research.

Learning Outcomes

www.unlv.edu/degree/ms-physics

Plan Admission Requirements

- Applicants must have a minimum GPA of 2.75 for all undergraduate work or a 3.00 GPA for the last two years of undergraduate work.
- The applicant must have completed 18 semester credits of upper-division undergraduate physics.
- All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements.

Plan Requirements

Total Credits Required: 30

Course Requirements

- Required Courses – Credits: 24
    - Complete 24 credits of 600- or 700-level AST or PHYS courses, or other advisor-approved courses.
- Thesis – Credits: 6
    - PHYS 797 - Thesis

Degree Requirements

- A minimum of 30 graduate credits is required, including a minimum of 15 credits (excluding thesis) in 700-level courses.
- A GPA of 3.00 or better is required in all course work which is part of the degree program.
- In consultation with his/her advisor, a student will organize a thesis committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.

Plan Graduation Requirements

- The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
- The student must successfully complete and defend a thesis by the posted deadline. The defense must be advertised and is open to the public.
- Student must submit his/her approved, properly formatted hard-copy thesis to the Graduate College, and submit the approved electronic version to ProQuest by the posted deadline.

Doctor of Philosophy - Astronomy

Plan Description

The purpose of the Astronomy M.S. and Ph.D. degrees are to prepare students for a career in Astronomy or Astrophysics Research or in education at the university level. The program achieves this with a custom program for each student set up by their advisor and their advising committee. In the case of the Ph.D. the research must be original research conducted independently by the student.

Learning Outcomes

www.unlv.edu/degree/phd-astronomy

Plan Admission Requirements

- Applicants must have an undergraduate degree or a Masters degree in Physics, Astronomy or related area.
- Applicants must have a minimum GPA of 2.75 for all undergraduate work or a minimum 3.00 GPA for the last two years of undergraduate work.
- Applicants seeking direct admission to the doctoral program without a previously earned Master of Science degree must have a score in the 65th percentile or above on the Advanced Physics portion of the GRE before admission and have a minimum GPA of 3.00 for all undergraduate work or an overall 3.25 GPA for the last two years of undergraduate work.
- Applicants with a Master's degree must have an overall 3.00 GPA in their Master's program and at least 15 credit hours of graduate-level course work in physics or astronomy with a grade of B or better. A student entering with a Master's degree will be required to complete at least 30 additional credits, including dissertation credits, beyond the Masters.
- All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements.

Plan Requirements

See Subplan Requirements below.

Subplan 1 Requirements: Post-Bachelor's Track

Total Credits Required: 60

Course Requirements

- Required Courses – Credits: 9
    - AST 713 - Astrophysics I
    - AST 714 - Astrophysics II
    - PHYS 700 - Mathematical Physics I
- Theory Course – Credits: 3
- Complete one of the following courses:
    - PHYS 702 - Classical Mechanics I
    - PHYS 711 - Electromagnetic Theory I
    - PHYS 721 - Quantum Theory I
- Astronomy Courses – Credits: 9
- Complete three of the following courses:
    - AST 710 - Observational Astronomy Techniques
    - AST 721 - Astrophysics of Gaseous Nebulae and Active Galactic Nuclei
    - AST 725 - High Energy Astrophysics
    - AST 727 - Cosmology
    - AST 731 - Stellar Atmospheres: Theory, Observation, and Analysis
    - AST 747 - Interstellar Medium
- PHYS 771 - Advanced Topics in Experimental and Theoretical Physics
- Graduate Seminar Course – Credits: 6
- Complete 6 credits of the following course, including three acceptable presentations.
- PHYS 796 - Graduate Seminar

- Elective Courses – Credits: 15
- Complete 15 credits of 600- or 700-level AST or PHYS courses, or other advisor-approved courses.
- Dissertation – Credits: 18
- PHYS 799 - Doctoral Dissertation

Degree Requirements

- The student must complete a minimum of 60 credits.
- A minimum grade of B- is required in each course. An overall GPA of 3.00 or better is required in all course work which is part of the degree program.
- Satisfactory performance on an astronomy qualifying examination on graduate astronomy knowledge. This requirement must be fulfilled by the second year in the program. Students who fail to pass the exam within the specified timeline will be placed on academic probation and will be allowed one retake of the exam. Failure to pass the retake or meet the requirements of academic probation will result in separation.
- A dissertation of high quality consisting of significant original research.
- Satisfactory performance on a final examination which will consist of an oral defense of the dissertation.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 2 Requirements: Post-Master's Track

Total Credits Required: 30

Course Requirements

- Required Courses – Credits: 0-9
  - Complete 0-9 credits from the following list of courses:
    - AST 713 - Astrophysics I
    - AST 714 - Astrophysics II
    - PHYS 700 - Mathematical Physics I
- Theory Course – Credits: 0-3
  - Complete 0-3 credits from the following list of courses:
    - PHYS 702 - Classical Mechanics I
    - PHYS 711 - Electromagnetic Theory I
    - PHYS 721 - Quantum Theory I
- Astronomy Courses – Credits: 0-9
  - Complete 0-9 credits from the following list of courses:
    - AST 710 - Observational Astronomy Techniques
    - AST 721 - Astrophysics of Gaseous Nebulae and Active Galactic Nuclei
    - AST 725 - High Energy Astrophysics
    - AST 727 - Cosmology
    - AST 731 - Stellar Atmospheres: Theory, Observation, and Analysis
    - AST 747 - Interstellar Medium
    - PHYS 771 - Advanced Topics in Experimental and Theoretical Physics
- Seminar Course – Credits: 0-6
  - Complete 0-6 credits of the following, including three acceptable presentations.

        - PHYS 796 - Graduate Seminar
- Dissertation – Credits: 18
    - PHYS 799 - Doctoral Dissertation

Degree Requirements

- Students must take an advisor approved combination of the coursework listed above, completing a minimum of 30 credits. Additional credits may be required to address student deficiencies or build specialized expertise.
- The total number of Required, Theory, Astronomy, and Seminar courses will be determined in consultation with the student's advisor.
- A minimum grade of B- is required in each course. An overall GPA of 3.00 or better is required in all course work which is part of the degree program.
- Satisfactory performance on an astronomy qualifying examination on graduate astronomy knowledge. This requirement must be fulfilled by the second year in the program. Students who fail to pass the exam within the specified timeline will be placed on academic probation and will be allowed one retake of the exam. Failure to pass the retake or meet the requirements of academic probation will result in separation.
- A dissertation of high quality consisting of significant original research.
- Satisfactory performance on a final examination which will consist of an oral defense of the dissertation.

Graduation Requirements

See Plan Graduation Requirements below.

Plan Graduation Requirements

- The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
- The student must pass a qualifying exam and submit and successfully defend his/her dissertation by the posted deadline. The defense must be advertised and is open to the public.
- The student must submit his/her approved, properly formatted hard-copy dissertation to the Graduate College, and submit the approved electronic version to ProQuest by the posted deadline.

Doctor of Philosophy - Physics

Plan Description

The purpose of the Physics M.S. and Ph.D. degrees are to prepare students for a career in Physics Research or in education at the university level. The program achieves this with a custom program for each student set up by their advisor and their advising committee. In the case of Ph.D. the students will be able to conduct these steps independently.

Learning Outcomes

www.unlv.edu/degree/phd-physics

Plan Admission Requirements

- Applicants seeking direct admission to the doctoral program without a previously earned Master of Science degree must have a score in the 65th percentile or above on the Advanced Physics portion of the GRE before admission. Applicants with a bachelor's degree in physics must have a minimum GPA of 3.00 for all undergraduate work or a 3.25 GPA for the last two years of undergraduate work, and a minimum of 18 credits of upper-division physics.
- Applicants with a master's degree in physics must have at least 15 credit hours of graduate-level course work in physics with a grade of B or better and a 3.25 GPA in the master's program.
- All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements.

Plan Requirements

See Subplan Requirements below.

Subplan 1 Requirements: Post-Bachelor's Track

Total Credits Required: 60

Course Requirements

- Required Courses – Credits: 18
    - PHYS 700 - Mathematical Physics I
    - PHYS 711 - Electromagnetic Theory I
    - PHYS 721 - Quantum Theory I
    - PHYS 721 - Quantum Theory I
    - PHYS 722 - Quantum Theory II
    - PHYS 731 - Statistical Physics I
- Elective Courses – Credits: 18
    - Complete 18 credits of 600- or 700-level AST or PHYS courses, or other advisor-approved courses.
- Graduate Seminar Course – Credits: 6
    - Complete 6 credits of the following, including three acceptable presentations.
        - PHYS 796 - Graduate Seminar
- Dissertation – Credits: 18
    - PHYS 799 - Doctoral Dissertation

Degree Requirements

- Students must complete a minimum of 60 credits.
- A minimum grade of B- is required in each course. An overall GPA of 3.00 or better is required on all course work that is part of the degree program.
- In consultation with his/her advisor, a student will organize a thesis committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.
- Each student's advisory committee will carry out an annual review of the student's progress.
- Course work taken outside the Physics & Astronomy Department must have departmental approval.
- Satisfactory performance on a written qualifying examination on advanced undergraduate physics must be fulfilled during the first two years in the graduate program. Students who fail to pass the exam within the

specified timeline will be placed on academic probation and will be allowed one retake of the exam. Failure to pass the retake or meet the requirements of academic probation will result in separation.

- A dissertation of high quality. The doctoral dissertation reports the results of significant original research, performed independently by the student, written in lucid scientific prose.
- Satisfactory performance on a final examination that will consist of an oral defense of the dissertation.

Graduation Requirements

See Plan Graduation Requirements below.

Subplan 2 Requirements: Post-Master's Track

Total Credits Required: 30

Course Requirements

- Required Courses – Credits: 6-18
  - Complete 6-18 credits from the following list of courses:
    - PHYS 700 - Mathematical Physics I
    - PHYS 711 - Electromagnetic Theory I
    - PHYS 712 - Electromagnetic Theory II
    - PHYS 721 - Quantum Theory I
    - PHYS 722 - Quantum Theory II
    - PHYS 731 - Statistical Physics I
- Graduate Seminar Course – Credits: 0-6
  - Complete 0-6 credits of the following, including three acceptable presentations.
    - PHYS 796 - Graduate Seminar
- Dissertation – Credits: 18
  - PHYS 799 - Doctoral Dissertation

Degree Requirements

- Students must take an advisor approved combination of the coursework listed above, completing a minimum of 30 credits. Additional credits may be required to address student deficiencies or build specialized expertise.
- The total number of Required Courses and Graduate Seminar Courses will be determined in consultation with the student's advisor.
- A minimum grade of B- is required in each course. An overall GPA of 3.00 or better is required on all course work that is part of the degree program.
- In consultation with his/her advisor, a student will organize a thesis committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.
- Each student's advisory committee will carry out an annual review of the student's progress.
- Course work taken outside the Physics & Astronomy Department must have departmental approval.
- Satisfactory performance on a written qualifying examination on advanced undergraduate physics must be fulfilled during the first two years in the graduate program. Students who fail to pass the exam within the

specified timeline will be placed on academic probation and will be allowed one retake of the exam. Failure to pass the retake or meet the requirements of academic probation will result in separation.

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- Satisfactory performance on a final examination that will consist of an oral defense of the dissertation.

Graduation Requirements

See Plan Graduation Requirements below.

Plan Graduation Requirements

- The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
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- The student must submit his/her approved, properly formatted hard-copy dissertation to the Graduate College, and submit the approved electronic version to ProQuest by the posted deadline.

Physics & Astronomy Courses

AST 710 - Observational Astronomy Techniques
Credits 3
Techniques used in observational astronomy. Students plan and execute an observing program on a research grade telescope. Data reduction and analysis using standard professional software packages and procedures. **Prerequisites** Graduate standing.

AST 713 - Astrophysics I
Credits 3
Laws of physics applied to astrophysical situations. **Notes** Major topics include solar physics, element synthesis, stellar evolution, end states of stars. **Prerequisites** Graduate standing.

AST 714 - Astrophysics II
Credits 3
Laws of physics applied to astrophysical situations. **Notes** Major topics include interstellar medium, the Milky Way, active galaxies, galaxy clusters, the Big Band. **Prerequisites** Graduate standing.

AST 721 - Astrophysics of Gaseous Nebulae and Active Galactic Nuclei
Credits 3
Theory and observations used to determine the physical conditions in gaseous nebulae (H II regions, planetary nebulae, supernova remnants, etc.) and active galactic nuclei. Formation of spectra in these regions and analysis to determine temperatures, density and chemical composition. Recent observational results also discussed. **Same as** Previously known as PHYS 777 . **Prerequisites** Graduate standing.

AST 723 - Astrophysical Fluids
Credits 3
Physics of fluids applied to astrophysical situations. Major topics include single-fluid theory, waves, shocks, fronts, magnetohydrodynamics, and plasma physics.

AST 725 - High Energy Astrophysics
Credits 3
Introduction of high energy astrophysics. Theory to understand high energy phenomena in the universe, including radiation mechanisms and various energy power sources (accretion, nuclear, spindown, magnetic). Objects include neutron stars, black holes, bursters. Brief introduction of neutrino, cosmic ray, and gravitational astrophysics.

AST 727 - Cosmology
Credits 3
Classical cosmology, the isotropic universe, gravitational lensing the age and distance scales, the early universe, observational cosmology, matter in the universe, galaxies and their evolution, active galaxies, galaxy formation and clustering, cosmic background fluctuations. **Same as** Previously known as PHYS 777. **Prerequisites** Graduate standing.

AST 729 - Galaxies
Credits 3
Observation and theoretical basis for our current understanding of galactic astronomy. Major topics include Morphology of Galaxies, the Milky Way, equilibria of collisionless systems, spiral structure , and dark matter. **Prerequisites** Graduate standing.

AST 731 - Stellar Atmospheres: Theory, Observation, and Analysis
Credits 3
Theoretical treatment of stellar atmospheric structure and radiative transfer, state-of-the-art astrophysical analysis techniques used to derive atmospheric parameters, our current observational understanding of stellar atmospheres, special topics in stellar atmospheres (pulsation, chromospheric activity, etc.), and relevance to galactic and extragalactic astronomy. **Prerequisites** Graduate standing.

AST 747 - Interstellar Medium
Credits 3
Physics of the interstellar medium. Overall chemical, thermal and physical state of the gas in our galaxy. Astrochemistry, cosmic rays, radiative transfer, atomic and molecular physics, thermal equilibrium, and the overall dynamics of the galaxy. **Same as** Previously known as PHYS 771 . **Prerequisites** Graduate standing.

PHYS 604 - Computational Techniques in Physics
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

PHYS 614 - Intermediate Laboratory II
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

PHYS 622 - Electricity and Magnetism
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

PHYS 624 - Mechanics
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found

in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

PHYS 626 - Physics of Solids
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

PHYS 631 - Nuclear and Elementary Particle Physics
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

PHYS 641 - Mathematical Physics I
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

PHYS 642 - Mathematical Physics II
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

PHYS 651 - Modern Scientific Instrumentation
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

PHYS 661 - Light and Physical Optics
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

PHYS 662 - Modern Optics and Photonics
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

PHYS 667 - Thermodynamics
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

PHYS 668 - Statistical Mechanics
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

PHYS 681 - Quantum Mechanics I

Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

PHYS 682 - Quantum Mechanics II
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

PHYS 683 - Special Topics in Physics
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

PHYS 685 - Condensed Matter Physics
Graduate credit may be obtained for courses designated 600 or above. A full description of this course may be found in the Undergraduate Catalog under the corresponding 400 number. **Notes** Credit at the 600 level normally requires additional work.

PHYS 700 - Mathematical Physics I
Credits 3
Reviews and introduces various specific mathematical functions and techniques basic to the study of physics.

PHYS 701 - Mathematical Physics II
Credits 3
Reviews and introduces various specific mathematical functions and techniques basic to the study of physics.

PHYS 702 - Classical Mechanics I
Credits 3
Newtonian mechanics from an advanced point of view. Variational principles. Lagrange's and Hamilton's equations, central forces, rigid body motion, canonical transformations, Hamilton-Jacobi theory, small oscillations.

PHYS 703 - Classical Mechanics II
Credits 3
Newtonian mechanics from an advanced point of view. Variational principles. Lagrange's and Hamilton's equations, central forces, rigid body motion, canonical transformations, Hamilton-Jacobi theory, small oscillations.

PHYS 705 - Advanced Optical Systems
Credits 3
Analysis and design of complete optical systems. Light sources and detectors. Matrix methods. Characteristics and application of optical components including lenses, mirrors, fibers, filters, holographic elements, prisms, and gratings. Apertures, stops, and pupils. Fourier optics. **Prerequisites** PHYS 461 or equivalent; graduate standing or consent of instructor.

PHYS 707 - Condensed Matter Theory I
Credits 3
Comparison of different band structure calculation methods. Local-density approximation. Relation of structural, transport, and optical properties to electronic structure. Properties of metals, insulators and semiconductors. Quantum theory of magnetism. **Prerequisites** PHYS 482/682, PHYS 483/683 and graduate standing.

PHYS 708 - Condensed Matter Theory II
Credits 3
Lattice dynamics. Electron-photon interaction. Elementary excitations. Many-body effects in condensed matter physics. Superconductivity. Phase transitions. Renormalization group theory. **Prerequisites** PHYS 707 and graduate standing.

PHYS 711 - Electromagnetic Theory I
Credits 3
General properties of vector fields with special application to electrostatic and magnetostatic fields. Solutions to boundary value problems. General electromagnetic equations and conservation theorems. Energy and momentum in the electromagnetic field. Motions of charged particles in electromagnetic fields. Electromagnetic theory of radiation electrodynamics and special relativity. Reflection, refraction, and dispersion of electromagnetic waves. **Prerequisites** PHYS 422/PHYS 622 and graduate standing.

PHYS 712 - Electromagnetic Theory II
Credits 3
General properties of vector fields with special application to electrostatic and magnetostatic fields. Solutions to boundary value problems. General electromagnetic equations and conservation theorems. Energy and momentum in the electromagnetic field. Motions of charged particles in electromagnetic fields. Electromagnetic theory of radiation electrodynamics and special relativity. Reflection, refraction, and dispersion of electromagnetic waves. **Prerequisites** PHYS 422/PHYS 622 and graduate standing.

PHYS 721 - Quantum Theory I
Credits 3
Development of quantum theory. Schroedinger equation, operators, expectation values. Matrix formalism of Heisenberg, eigenvalue problems, wave packets, conjugate variables, and uncertainty principle. Solution of wave equation for square potentials, harmonic oscillator, and hydrogen-like atoms. Perturbation theory, both time-independent and time-dependent. Degeneracy, interaction of matter with radiation, selection rules. Scattering theory, Born approximation and other approximation methods. Dirac notation and an introduction to spin. **Prerequisites** PHYS 482/PHYS 682 and graduate standing.

PHYS 722 - Quantum Theory II
Credits 3
Development of quantum theory. Schroedinger equation, operators, expectation values. Matrix formalism of Heisenberg, eigenvalue problems, wave packets, conjugate variables, and uncertainty principle. Solution of wave equation for square potentials, harmonic oscillator, and hydrogen-like atoms. Perturbation theory, both time-independent and time-dependent. Degeneracy, interaction of matter with radiation, selection rules. Scattering theory, Born approximation and other approximation methods. Dirac notation and an introduction to spin. **Prerequisites** PHYS 482/PHYS 682 and graduate standing.

PHYS 723 - Quantum Optics
Credits 3
Properties of light, its creation, and its interaction with matter explored as quantum-mechanical phenomena. Quantization of the light field. Quantum theory of coherence. Dissipation and fluctuations. Light amplification. Nonlinear optics. **Prerequisites** PHYS 622 and PHYS 682/PHYS 721, or consent of instructor.

PHYS 724 - Laser Applications: Interaction with Matter
Credits 3

Laser principles. Introduction to laser spectroscopy, isotope separation, and trace element analysis. Laser induced fusion. Laser induced plasmas and their radiation. **Prerequisites** Graduate standing or consent of instructor.

PHYS 725 - Spectroscopy
Credits 3
Survey of spectroscopy, including absorption and emission spectroscopy, classical grating spectroscopy, laser spectroscopy, Raman spectroscopy, and Fourier transform spectroscopy. Intensities, sensitivity limits, and resolution. High-resolution and ultra-high-resolution spectroscopy. Photon correlation spectroscopy. Analysis of spectra. **Prerequisites** PHYS 461/PHYS 661, PHYS 481/PHYS 681 and graduate standing.

PHYS 726 - Advanced Quantum Theory
Credits 3
The Dirac equation, hole theory, second quantization, Feynman diagrams, self-energy, vacuum polarization, renormalization, QED effects in high-Z atoms, path integral methods in field theory. **Prerequisites** PHYS 722 and graduate standing.

PHYS 727 - Advanced Topics in Semiconductor Devices I
Credits 3
Topics of current interest in solid state electronic devices: physics of semiconductors, thermal and optical and electronic properties of semiconductors, bipolar junction devices, field effect devices, surface related effects, optoelectronic devices, semiconductor lasers. Applications and the design of circuits using these devices. Intended for electrical and electronic engineers, physicists, and qualified senior students in engineering and physics. **Prerequisites** PHYS 411 and PHYS 683, or EEG 414 and EEG 420, and consent of instructor.

PHYS 728 - Applications of Group Theory in Quantum Mechanics
Credits 3
Abstract group theory, theory of group representations, and direct product theory. Relationship to quantum mechanics; applications to atomic, molecular and solid state physics. Time-reversal symmetry, continuous groups, and the symmetric group. **Prerequisites** PHYS 482/PHYS 682 and graduate standing.

PHYS 731 - Statistical Physics I
Credits 3
Liouville's theorem, ensembles, Boltzmann and Gibbs methods. Non-ideal gases, cluster expansions, theory of condensation. **Prerequisites** PHYS 467, 468 and graduate standing.

PHYS 732 - Statistical Physics II
Credits 3
Quantum statistical mechanics, Fermi-Dirac and Bose- Einstein statistics. Phase transitions. Fluctuations. **Prerequisites** PHYS 731 and graduate standing.

PHYS 741 - Atomic and Molecular Theory
Credits 3
Hartree-Fock theory, many-body perturbation theory, relativistic effects, energy levels, oscillator strengths, boundcontinuum processes, Born-Oppenheimer approximation for molecules, symmetries, selection rules. **Prerequisites** PHYS 721 and graduate standing.

PHYS 771 - Advanced Topics in Experimental and Theoretical Physics
Credits 3
Consists of lectures dealing with experimental and theoretical aspects of one of the fields listed. a) Electrodynamics.

b) Fluid mechanics. c) Plasma physics. d) Quantum theory. e) Nuclear physics. f) Atomic and molecular physics. g) Electron and ion physics. h) Low-temperature physics. i) Solid and/ r liquid state. k) Cosmic rays. l) Relativity. m) Elementary particles. p) Astrophysics. r) Atmospheric Physics. s) Geophysics. t) Applied Optics. **Notes** May be repeated for credit in different fields to a maximum of 12 credits. **Prerequisites** Depends on particular topic, consult instructor.

PHYS 777 - Advanced Special Problems
Credits 1–6
Special study of advanced topics not specifically covered in listed courses. **Notes** May be repeated to a maximum of six credits. **Prerequisites** Prior conference with instructor.

PHYS 781 - Thesis Research
Credits 1
Research leading to master's level program prospectus. **Notes** May be repeated but only one credit can be applied to the student's program. **Grading** S/F grading only. **Prerequisites** Enrollment in the M.S. Program.

PHYS 782 - Dissertation Research
Credits 1
Supervised research prior to advancement to candidacy in the doctoral program. **Notes** May be repeated but only two credits can be applied to the student's program. A maximum of one credit is allowed per semester. **Grading** S/F grading only. **Prerequisites** enrollment in the doctoral program.

PHYS 796 - Graduate Seminar
Credits 1
Students required to give presentations on topics outside their Ph.D. work and to discuss the presentations. Presentations by graduate students given on a regularly scheduled basis, last about an hour, and given at the nonspecialist level. **Notes** A total of three acceptable presentations in three different semesters during the six semesters of enrollment required. May be repeated to a maximum of six credits. **Prerequisites** Graduate standing.

PHYS 797 - Thesis
Credits 3–6. **Notes** May be repeated but only six credits will be applied to the student's program. **Grading** S/F grading only.

PHYS 799 - Doctoral Dissertation
Credits 3–6
Doctoral dissertation. **Notes** May be repeated. A minimum of 18 credits required for the degree. **Prerequisites** Qualifying exam and approval by department.

Water Resources Management

The Water Resources Management Program is a flexible, interdisciplinary course of study leading to an M.S. degree. It is a technically and scientifically based program that blends the physical aspects of the hydrologic sciences, in a broader sense, with policy and management issues in hydroscience. People with degrees in physical, biological, or natural sciences and engineering and those with degrees in the social sciences, management, environmental studies, or related disciplines are encouraged to apply to the program. Working together, the student and faculty advising committee will design specific courses of study or thesis topics such that all students will strengthen their understanding of hydrologic sciences and water management while also developing technical skills.

The Water Resources Management Graduate Program is housed in the College of Sciences and encourages multidisciplinary study and research with participating faculty at UNLV from the colleges of Sciences, Business, Urban Affairs, Engineering, and Liberal Arts and participating faculty at the Harry Reid Center for Environmental Studies (HRC) on the UNLV campus, the Desert Research Institute (DRI), and the University of Nevada, Reno (UNR). Adjunct participating faculty may also be with the U.S. Environmental Protection Agency (EPA), the U. S. Geological Survey (USGS), Department of Energy (DOE), Las Vegas Valley Water District (LVVWD), the Bureau of Reclamation (BOR) or other governmental or private agencies.

Michael Nicholl, Ph.D., Director, Graduate Coordinator

Director

Papelis, Charalambos
Associate Research Professor; B.S., National Technical University, Athens, Greece; M.S., Ph.D., Stanford University. *Rebel since 1994.*

Graduate Faculty

Faculty participating in the Water Resources Management Graduate Program (WRM) are affiliated with several different colleges, departments, and centers of UNLV and the NSHE. Researchers from governmental or private agencies may also participate as adjunct faculty. A list of participating faculty can be found at the website of the WRM Graduate Program at http://sciences.unlv.edu/wrm.

Water Resources Management Plan

Master of Science - Water Resources Management

Plan Description

The Water Resources Management (WRM) program in the College of Sciences at the University of Nevada, Las Vegas is a flexible, interdisciplinary course of study leading to a Master of Science degree. It is a technically and scientifically based program that blends the physical aspects of the hydrologic sciences with policy and management issues.

The WRM program is designed to encourage a multidisciplinary approach to learning. Students enter the program from a wide variety of undergraduate programs, then take classes and conduct research with faculty in the Colleges of: Sciences, Business, Urban Affairs, Engineering, and Liberal Arts at UNLV, plus the Boyd School of Law and the Desert Research Institute. Students in the WRM program also work with participating faculty from federal, state, and local government agencies.

Learning Outcomes

www.unlv.edu/degree/ms-water-resource-management

Plan Admission Requirements

Applicants to the program must hold a B.S. or B.A. degrees in the physical, natural or social sciences, business, management, or a related field.

1. A minimum overall undergraduate grade point average of 3.00.
2. Submission of an online application.
3. Transcripts of all college-level course work.
4. Three letters of recommendation from individuals competent to comment on the applicant's promise as a graduate student.
5. A letter of application stating the student's interests and goals.
6. Satisfactory scores on the Graduate Record Exam. This requirement may be waived in the case of candidates with exceptional professional experience.

Items 3-5 should be uploaded as part of the online application.

All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements.

Refer to the Graduate College website for current deadlines.

Plan Requirements

See Subplan Requirements below.

Subplan 1 Requirements: Thesis Track

Total Credits Required: 33

Course Requirements

- Required Course – Credits: 3
  - Complete one of the following courses:
    - WRM 706 - Research Methods in Water Resources Management
    - GEOL 701 - Research Methods in Geoscience
- Hydrologic Sciences Courses – Credits: 6
  - Complete 6 credits of advisor-approved GEOL or CEE courses.
- Additional Science Course – Credits: 3
  - Complete 3 credits of advisor-approved science, mathematics or engineering (BIOL, CEE, CHEM, GEOL, MAT, ME, PHYS, STA) courses.
- Administrative Courses – Credits: 9
  - Complete 9 credits of advisor-approved management, public administration, economics, law, or political science (ECO, ENV, HIST, LAW, MGT, MIS, PSC, PUA) courses.

- Elective Courses – Credits: 6
    - Complete 6 credits of advisor-approved BIOL, CEE, CHEM, ECO, ENV, GEO, HIST, LAW, MAT, ME, MGT, MIS, PHYS, PSC, PUA, or STA courses.
- Thesis – Credits: 6
    - WRM 798 - Thesis

Degree Requirements

- Completion of a minimum of 33 credit hours with a minimum GPA of 3.00.
- A minimum of 15 credit hours must be in 700-level courses.
- Because of the interdisciplinary nature of the Water Resources Management Graduate Program, students are encouraged to select courses from different departments that would strengthen their background and help them achieve their research and educational goals.
- In consultation with his/her advisor, a student will organize a thesis committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.
- Students must develop their course work program with the consent of the advisor and the student's advisory committee. Courses from different colleges and departments may be incorporated into the student's program of study. Students should consult the listings of individual departments.
- There will be a final examination that will include a comprehensive oral examination.

Graduation Requirements

- The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
- The student must submit and successfully defend his/her thesis by the posted deadline. The defense must be advertised and is open to the public.
- The student must submit his/her approved, properly formatted hard-copy thesis to the Graduate College, and submit the approved electronic version to ProQuest by the posted deadline.

Subplan 2 Requirements: Non-Thesis Track

Total Required Credits: 36

Course Requirements

- Required Course – Credits: 3
    - Complete one of the following courses:
        - WRM 706 - Research Methods in Water Resources Management
        - GEOL 701 - Research Methods in Geoscience
- Hydrologic Sciences Courses – Credits: 6
    - Complete 6 credits of advisor-approved GEOL or CEE courses.
- Additional Science Courses – Credits: 6
    - Complete 6 credits of advisor-approved science, mathematics or engineering (BIOL, CEE, CHEM, GEOL, MAT, ME, PHYS, STA) courses.
- Administrative Courses – Credits: 12
    - Complete 12 credits of advisor-approved management, public administration, economics, law, or political science (ECO, ENV, HIST, LAW, MGT, MIS, PSC, PUA) courses.
- Elective Courses – Credits: 6

    - Complete 6 credits of advisor-approved BIOL, CEE, CHEM, ECO, ENV, GEO, HIST, LAW, MAT, ME, MGT, MIS, PHYS, PSC, PUA, or STA courses.
- Professional Paper – Credits: 3
    - WRM 796 - Professional Paper in WRM

Degree Requirements

- Completion of a minimum of 36 credit hours with a minimum GPA of 3.00.
- A minimum of 15 credit hours must be in 700-level courses.
- Because of the interdisciplinary nature of the Water Resources Management Graduate Program, students are encouraged to select courses from different departments that would strengthen their background and help them achieve their research and educational goals.
- In consultation with his/her advisor, a student will organize a thesis committee of at least three departmental members. In addition, a fourth member from outside the department, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.
- Students must develop their course work program with the consent of the advisor and the student's advisory committee. Courses from different colleges and departments may be incorporated into the student's program of study. Students should consult the listings of individual departments.
- There will be a final examination that will include a comprehensive oral examination.

Graduation Requirements

- The student must submit all required forms to the Graduate College and then apply for graduation up to two semesters prior to completing his/her degree requirements.
- The student must successfully complete and defend a professional paper.

Plan Graduation Requirements

Refer to your subplan for Graduation Requirements.

- Subplan 1: Thesis Track
- Subplan 2: Non-Thesis Track

Water Resources Management Courses

WRM 706 - Research Methods in Water Resources Management
Credits 3
Discussion of the processes of scientific research and research design as applied to modern water resources management. Includes scientific approaches to field and laboratory research, research and professional ethics, writing, and public presentation. Model thesis prospectus and grant proposals prepared. **Prerequisites** Graduate standing or consent of instructor.

WRM 790 - Special Topics in Water Resources Management
Credits 1–3
Topics selected and published in the class schedule. **Notes** May be repeated to a maximum of nine credits. **Prerequisites** Consent of instructor.

WRM 791 - Independent Study
Credits 1–3
Review of recent literature in a specialized area related to water resources. **Notes** May be repeated to a maximum of four credits. **Prerequisites** Consent of instructor.

WRM 796 - Professional Paper in WRM
Credits 1–6
Professional paper preparation, including review of literature or similar research effort. **Notes** May be repeated to a maximum of three credits. Not permitted for students pursuing the M.S. Thesis option. **Prerequisites** Consent of instructor.

WRM 798 - Thesis
Credits 1–3
Enrollment by consent of research director only. **Notes** May be repeated for credit with cumulative maximum of six credits allowed toward degree program. **Grading** S/F grading only.