# 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.

*Eric L. Chronister, Dean*
*Javier A. Rodriguez, Associate Dean*

## Chemistry and Biochemistry

The Department of Chemistry and Biochemistry offers the Ph.D. in Chemistry or Ph.D. in Radiochemistry and the M.S. in Chemistry or the M.S. in 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 Department of Chemistry and Biochemistry, 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.

*Spencer Steinberg, Ph.D., Chair*
*Kathleen Robins, Ph.D., Graduate Coordinator*
*Thomas Hartmann, Ph.D., Graduate Coordinator - Radiochemistry (Ph.D.)*

**Chemistry Faculty**

**Chair**

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

**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 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 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 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.

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

Heske, Clemens - Full Graduate Faculty 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 Associate Professor, Biochemistry.

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

Naduvalath, Balakrishnan - Full Graduate Faculty 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 Associate Professor; Chemical Education; B.S. Brigham Young University; M.S., Ph.D., Purdue University. Rebel since 2003.

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

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

Tirri, Lawrence J. - Full Graduate Faculty Associate 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.

## 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.

For more information about your program, including your graduate program handbook and learning outcomes please visit the Degree Directory.

**Plan Admission Requirements**

Application deadlines available on the UNLV Graduate College website.

Applications available on the UNLV Graduate College website.

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

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.
2. 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.
3. 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.
4. 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.
5. 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.
6. The Department of Chemistry requires scores for GRE, General Record Exam, for admission.
7. All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements.

Students are accepted into a degree program as described in the Graduate Catalog. The faculty and corresponding sub-disciplines and sub-plans within the described programs are subject to change at any time.

**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 691 - Graduate Seminar in Chemistry
A minimum of 3 presentations are required.

**Coursework Elective Courses – Credits: Minimum of 12**

A minimum of 12 credits of advisor-approved coursework electives. These courses may include but are not limited to:

CHEM 710 - Environmental Aquatic Chemistry

CHEM 715 - Environmental Organic Chemistry

CHEM 725 - Advanced Organic Chemistry

CHEM 726 - Organic Synthesis

CHEM 735 - Advanced Physical Chemistry

CHEM 745 - Instrumental Analysis-Inorganic

CHEM 749 - Polymer Chemistry

CHEM 750 - Quality Assurance and Statistics

CHEM 770 - Protein Chemistry

CHEM 771 - Metabolism and Energetics

CHEM 772 - Nucleic Acid Chemistry

CHEM 773 - Physical Biochemistry

CHEM 775 - Bioanalytical Environmental Toxicology

CHEM 783 - Spectral Interpretation

CHEM 793 - Special Topics

**Research Elective Courses – Credits: 31**

Complete 31 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**

1. Doctoral students in Chemistry are required to complete a minimum of 60 credit hours beyond the baccalaureate.
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. All students must meet with their advisory committee on a yearly basis, and all students must complete an annual evaluation form.
4. 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 pr m.
5. 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.
6. 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.
7. 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.
8. 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.
9. 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.
10. 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 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.
    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 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.
    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.

11. 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 research-based manuscripts in peer-reviewed journals.

**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 691 - Graduate Seminar in Chemistry
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 710 - Environmental Aquatic Chemistry

CHEM 715 - Environmental Organic Chemistry

CHEM 725 - Advanced Organic Chemistry

CHEM 726 - Organic Synthesis

CHEM 735 - Advanced Physical Chemistry

CHEM 745 - Instrumental Analysis-Inorganic

CHEM 749 - Polymer Chemistry

CHEM 750 - Quality Assurance and Statistics

CHEM 770 - Protein Chemistry

CHEM 771 - Metabolism and Energetics

CHEM 772 - Nucleic Acid Chemistry

CHEM 773 - Physical Biochemistry

CHEM 775 - Bioanalytical Environmental Toxicology

CHEM 783 - Spectral Interpretation

CHEM 793 - Special Topics

**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. All students must meet with their advisory committee on a yearly basis, and all students must complete an annual evaluation form.
4. 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.
5. 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.
6. 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.
7. 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.
8. 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.
9. 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.

10. 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
11. 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 research-based manuscripts in peer-reviewed journals.

**Graduation Requirements**
See Plan Graduation Requirements below.

**Plan Graduation Requirements**
1. 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.
2. 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.

## 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.

For more information about your program, including your graduate program handbook and learning outcomes please visit the Degree Directory.

**Plan Admission Requirements**
Application deadlines available on the UNLV Graduate College website.

Applications available on the UNLV Graduate College website.

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:**
1. Completed Graduate College Application including applicable fees.
2. 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.
3. 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.
4. A current resume.
5. 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.
6. A score ranking in the 50th percentile or higher in the verbal and quantitative sections of the Graduate Record Exam (GRE).
7. Students meeting all of the above admission requirements may be asked to meet with the admission committee for a personal interview.

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

Students are accepted into a degree program as described in the Graduate Catalog. The faculty and corresponding sub-disciplines and sub-plans within the described programs are subject to change at any time.

**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.
   1. 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.
   2. 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.

3. 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.
4. Students must schedule and take the oral qualifying exam within 1.5 years of satisfactorily completing the core Radiochemistry courses.

2. 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.
3. 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.
4. 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.
5. 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.
6. 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**

1. 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.
2. 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.
3. 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.

## 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.

For more information about your program, including your graduate program handbook and learning outcomes please visit the Degree Directory.

**Plan Admission Requirements**

Application deadlines available on the UNLV Graduate College website.

Applications available on the UNLV Graduate College website.

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.

Students are accepted into a degree program as described in the Graduate Catalog. The faculty and corresponding sub-disciplines and sub-plans within the described programs are subject to change at any time.

**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**

1. Students must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
2. No grade lower than C is acceptable, and only one grade below B- is permitted.
3. At least 12 credits of electives must be in courses at the 700-level.
4. 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.
5. 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.
6. 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.
7. 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**

1. 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.
2. 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.
3. 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 - 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.

For more information about your program, including your graduate program handbook and learning outcomes, please visit the Degree Directory.

**Plan Admission Requirements**

Application deadlines available on the UNLV Graduate College website.

Applications available on the UNLV Graduate College website.

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.

Students are accepted into a degree program as described in the Graduate Catalog. The faculty and corresponding sub-disciplines and sub-plans within the described programs are subject to change at any time.

**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**

1. Students must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
2. No grade lower than C is acceptable, and only one grade below B- is permitted.
3. At least 12 credits of electives must be in courses at the 700-level.
4. 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.
5. 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.
6. 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.
7. 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.
8. 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**

1. 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.
2. 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.
3. 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.

**CHEM 602 - Scientific Software for the Microcomputer Credits 1**
Use of computer software for graphing, statistics, structure drawing, information retrieval, word processing, and self-paced learning. Note(s): This course is crosslisted with CHEM 402. Credit at the 600-level requires additional work.

**CHEM 621 - Physical Chemistry Credits 3**
Thermodynamics, solution behavior, and equilibrium. Note(s): This course is crosslisted with CHEM 421. Credit at the 600-level requires additional work.

**CHEM 622 - Physical Chemistry II Credits 3**
Kinetic theory, chemical kinetics, electrochemistry, introductory quantum chemistry, and states of matter. Note(s): This course is crosslisted with CHEM 422. Credit at the 600-level requires additional work.

**CHEM 628 - Quantum Chemistry Credits 3**
Introduction to quantum mechanics and molecular orbital theory as related to bonding, spectra, and reactivity. Includes an introduction to computerized electronic structure calculations. Note(s): This course is crosslisted with CHEM 428. Credit at the 600-level 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. Prerequisite(s): CHEM 422 or equivalent.

**CHEM 649 - Polymer Chemistry Credits 3**
Synthesis, characterization, morphology, bulk and solution properties of polymers; polymerization mechanisms. Note(s): This course is crosslisted with CHEM 449. Credit at the 600-level requires additional work. Prerequisite(s): Graduate standing.

**CHEM 655 - Instrumental Analysis Credits 4**
Fundamental laws and principles of instrumental determinations, including spectroscopy, spectrophotometry, electrochemical methods, and thermal analysis as main areas of study. Note(s): This course is crosslisted with CHEM 455. Credit at the 600-level requires additional work.

**CHEM 672 - Biochemistry Laboratory Credits 2**
Introduction to analytical techniques of biochemistry as tools to study cellular components. Techniques may include centrifugation, spectrophotometry, chromatography, and electrophoresis. Note(s): This course is crosslisted with CHEM 472. Credit at the 600 level 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. Note(s): May be repeated (different topic) once for a total of 6 credits to be applied toward graduate degree program. This course is crosslisted with CHEM 476. Credit at the 600-level requires additional work. Prerequisite(s): CHEM 475, graduate standing or permission of instructor.

**CHEM 678 - Endocrinology Credits 3**
Survey of the structure and function of vertebrate endocrine systems, with emphasis on the biochemical basis of hormone action and the role of cell communication in endocrine physiology. *Same as* BIOL 448 Note(s): This course is crosslisted with CHEM 478. Credit at the 600-level requires additional work.

**CHEM 691 - Graduate Seminar in Chemistry Credits 1**
Attendance and participation in seminar presentations and discussions of specialized topics. Includes student presentations. Students required to enroll for a minimum of two semesters and present a minimum of two presentations. Note(s): May be repeated to a maximum of six credits. Grading: S/F

**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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Note(s): Eight hours laboratory per week. Prerequisite(s): 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. Prerequisite(s): CHEM 421 and 428

**CHEM 745 - Instrumental Analysis-Inorganic Credits 3**
Theory of modern analytical instrumentation as it pertains to inorganic analysis. Note(s): 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. Prerequisite(s): 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. Note(s): Not a theoretical statistics course. Prerequisite(s): 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. Prerequisite(s): 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. Note(s): One hour lecture and six hours laboratory. Consult instructor(s) prior to enrollment. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): CHEM 422

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

**CHEM 772 - Nucleic Acid Chemistry Credits 3**
Chemistry and function of nucleic acids (DNA, RNA) and their analogs. Prerequisite(s): 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). Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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(s): CHEM 783

**CHEM 790 - Directed Readings** **Credits 1**
Directed readings in the primary literature supportive of the dissertation prospectus. Note(s): May be repeated, but only three credits are applied to the academic program. Prerequisite(s): 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. Note(s): May be repeated for a maximum of five credits. Grading: S/F Prerequisite(s): Graduate standing in Chemistry or Radiochemistry.

**CHEM 792 - Research Seminar** **Credits 3**
Public defense of a graduate research project in the Ph.D. Program. Prerequisite(s): 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. Note(s): May be repeated for credit if classes are in different topics. Prerequisite(s): Graduate standing in Chemistry or Biochemistry or Radiochemistry.

**CHEM 795 - Independent Study** **Credits 1 – 3**
Individual directed study of a topic not covered in other courses. Note(s): May be repeated once for credit. May be repeated to a maximum of 12 credits. Prerequisite(s): 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. Prerequisite(s): Enrollment in the Chemistry or Radiochemistry doctoral program.

**CHEM 797 - Directed Research** **Credits 1 – 6**
Supervised research in the doctoral program. Note(s): May be repeated for a maximum of 18 credits. Prerequisite(s): Enrollment in the Chemistry or Radiochemistry doctoral program.

**CHEM 798 - Thesis** **Credits 3 – 6**
Note(s): May be repeated, but only nine credits applied to the student's program. Grading: S/F grading only. Prerequisite(s): 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. Note(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): Undergraduate chemistry laboratory experience, graduate standing in the Radiochemistry program.

## Geoscience

The Department of Geoscience is an active and enthusiastic department consisting of twenty-two 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. Active research by faculty and students is ongoing throughout the western United States, as well as in, Canada, Chile, China, Costa Rica, Indonesia, France, Guatemala, Mexico, New Zealand, Panama, Poland, Russia, South Africa, Spain, and Switzerland. The geoscience curriculum is designed to develop student skills applicable to employment opportunities in a wide array of disciplines in the geoscience sector.

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 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 website. An understanding of these documents is essential for satisfactory progress toward the degree.

*Terry Spell, Ph.D., Chair*
*Rodney V. Metcalf, Ph.D., Graduate Program Coordinator*
*Elisabeth (Libby) Hausrath, Ph.D., Graduate Admissions Coordinator*

**Geoscience Faculty**

**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**

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

**Graduate Faculty**

Bonde, Josh - Full Graduate Faculty Assistant Professor in Residence; B.S., University of Nevada Reno; M.S., Montana State University; Ph.D., University of Nevada Las Vegas. Rebel since 2014.

Buck, Brenda- Full Graduate Faculty 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.

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 Associate Professor; B.S., Brown University; Ph.D., Pennsylvania State University. Rebel since 2009.

Huang, Shichun - Full Graduate Faculty Assistant Professor; B.S., University of Science and Technology of China; Ph.D., Massachusetts Institute of Technology. Rebel since 2014.

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

Jowitt, Simon - Full Graduate Faculty Assistant Professor; B.S. University of Edinburgh;, M.S., University of Exeter; Ph.D., University of Leicester. Rebel since 2016.

Judkins, Gabriel - Full Graduate Faculty Assistant Professor in Residence; B.S., State University of New York Geneseo; M.S., Ph.D., Arizona State University. Rebel since 2009.

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

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

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.

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.

Udry, Arya - Full Graduate Faculty Assistant Professor; B.S., M.S., Universite de Lausanne (Switzerland); Ph.D., University of Tennessee. Rebel since 2014.

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.

Cline, Jean S. - Full Graduate Faculty Emeritus Professor; B.S., Wisconsin State University; M.S., University of Arizona; Ph.D., Virginia Polytechnic Institute and State University. UNLV Emeritus 1990-2014.

Smith, Eugene I. - Full Graduate Faculty Emeritus Professor; B.S., Wayne State University; M.S., Ph.D., University of New Mexico. UNLV Emeritus 1980-2013.

## 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.

For more information about your program, including your graduate program handbook and learning outcomes, please visit the Degree Directory.

**Plan Admission Requirements**
Application deadlines available on the UNLV Graduate College website.

Applications available on the UNLV Graduate College website.

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

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

1. For the Post-Bachelor's Track: A bachelor's degree in geology or equivalent.
2. For the Post-Master's Track: A Master of Science degree in geology or equivalent.
3. 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.

Students are accepted into a degree program as described in the Graduate Catalog. The faculty and corresponding sub-disciplines and sub-plans within the described programs are subject to change at any time.

**Plan Requirements**
See Subplan Requirements below.

**Subplan 1 Requirements: Post-Bachelor's - Geoscience 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**
1. Students must complete a minimum of 60 credit hours with a minimum GPA of 3.00.
2. A minimum of 24 of the 60 credits required must be at the 700-level.
3. 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.
4. Doctoral students are encouraged to take courses from outside of geoscience; however, a minimum of 15 credits must be geoscience (GEOL) courses.
5. 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.
6. Satisfactory progress toward meeting the degree requirements is required of all candidates. Satisfactory progress is defined as, at a minimum:
   a. 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.
   b. 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.
   c. 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.
   d. 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.
   e. 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.

f. 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.
g. 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 fourth semester, whichever comes first. The Comprehensive Examination can be taken either entirely as an oral examination or with both oral and written components. The decision of which of these options to take is decided by unanimous agreement by the student's doctoral advising committee. In the case of non-unanimous agreement, both the oral and written components will be given.
h. Preparation of a dissertation proposal and satisfactory performance on a Proposal Defense Examination. This examination must be completed prior to the end of the fifth 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 after the Comprehensive Examination.
i. 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.
j. 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.

7. 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.
8. It is recommended that the student be a teaching assistant or instructor for at least one semester.
9. 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-Master's - Geoscience 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**
1. Students must complete a minimum of 36 credit hours with a minimum GPA of 3.00.
2. A minimum of 12 of the 36 credits required must be at the 700-level.
3. 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.
4. Doctoral students are encouraged to take courses from outside of geoscience; however, a minimum of 15 credits must be geoscience (GEOL) courses.
5. 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.
6. Satisfactory progress toward meeting the degree requirements is required of all candidates. Satisfactory progress is defined as, at a minimum:
   a. 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.

b. 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.
c. 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.
d. 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.
e. 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.
f. 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 fourth semester, whichever comes first. The Comprehensive Examination can be taken either entirely as an oral examination or with both oral and written components. The decision of which of these options to take is decided by unanimous agreement by the student's doctoral advising committee. In the case of non-unanimous agreement, both the oral and written components will be given.
g. 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 after to the Comprehensive Examination.
h. 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.
i. 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.

7. 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.
8. It is recommended that the student be a teaching assistant or instructor for at least one semester.
9. 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**

1. 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.
2. 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.
3. 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.

## 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.

For more information about your program including your graduate program handbook and learning outcomes please visit the Degree Directory.

**Plan Admission Requirements**
Application deadlines available on the UNLV Graduate College website.

Applications available on the UNLV Graduate College website.

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

**Geoscience**
The Geoscience MS degree 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:

1. A bachelor's degree in geology or an appropriate but closely-related equivalent.
2. 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.

Students are accepted into a degree program as described in the Graduate Catalog. The faculty and corresponding sub-disciplines and sub-plans within the described programs are subject to change at any time.

**Plan Requirements: Geoscience**
**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.

**Plan Degree Requirements**
1. Students must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
2. At least 12 credits (excluding thesis) must be in 700-level courses.
3. GEOL 701 and GEOL 795 must be taken during the first year of enrollment.
4. 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.
5. 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.
6. 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.
7. 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. 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.

Consult the Geoscience Graduate Student Guidelines at http://geoscience.unlv.edu/graduatestudentguidelines.htm for full details.

**Plan Graduation Requirements**
1. 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.
2. 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.
3. 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.

**GEOG 621 - Climatology** **Credits 3**
Physical characteristics of the atmosphere. World climatic classification. Local atmospheric field study. Note(s): This course is crosslisted with GEOG 421. Credit at the 600-level requires additional work. Prerequisite(s): GEOG 103 or consent of instructor.

**GEOL 610 - Soil Classification and Resource Management** **Credits 4**
Morphology and classification of soils based on their physical, chemical and mineralogical composition. Introduction to soil genesis, soil mapping, and the relationship of soils to the limitations and potentials of land use. Note(s): This course is crosslisted with GEOL 410. Credit at the 600-level requires additional work.

**GEOL 619 - Medical Geology** **Credits 3**
Medical Geology is the science surrounding the relationship between geological factors and health in humans, animals, and plants. This class focuses on the relationships between geology and human health. Note(s): This course is crosslisted with GEOL 419. Credit at the 600-level requires additional work.

**GEOL 620 - Introduction to X-ray Diffraction and X-ray Spectrometry Methods** **Credits 4**
Introduction to the principles and methods of x-ray analysis as applied to the study of minerals. Powder camera, diffractometry and spectrometry methods covered. Two hours lecture and six hours laboratory. Note(s): This course is crosslisted 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. Note(s): This course is crosslisted with GEOL 425. Credit at the 600-level requires additional work. Prerequisite(s): College level chemistry or geochemistry.

**GEOL 627 - Igneous and Metamorphic Petrology/Petrography** **Credits 4**
Description, classification, and interpretation of igneous and metamorphic rocks in hand specimen and thin section. Note(s): This course is crosslisted with GEOL 427. Credit at the 600-level requires additional work. Prerequisite(s): Consent of instructor.

**GEOL 629 - Geochemical Thermodynamics and Kinetics** **Credits 3**
Survey of the basic principles of thermodynamics and kinetics and their application to geological processes; applications to include igneous, metamorphic, hydrothermal, diagenetic, weathering, and aqueous systems. Note(s): This course is crosslisted with GEOL 429. Credit at the 600-level requires additional work.

**GEOL 630 - Geographic Information Systems (GIS): Theory and Applications** **Credits 4**
Survey of computer-based techniques in the storage, retrieval, analysis, and representation of spatially referenced data. Emphasis on the application of GIS technology to geologic problems such as natural hazard mapping, surface runoff and erosion, and environmental impact assessment. Note(s): This course is crosslisted with GEOL 430. Credit at the 600-level requires additional work.

**GEOL 633 - Glacial and Periglacial Geology** **Credits 3**
Origin and regimen of glaciers. Geomorphology and stratigraphic analysis of glacial and associated non-glacial deposits and environments. Note(s): This course is crosslisted with GEOL 433. Credit at the 600-level requires additional work.

**GEOL 634 - Quaternary Geology** **Credits 3**
Survey of global paleoenvironments, including geologic, climatic, and biotic changes during the Quaternary. Examination of the geological record of marine and terrestrial glaciated and nonglaciated environments. Note(s): This course is crosslisted with GEOL 434. Credit at the 600-level requires additional work.

**GEOL 636 - Quaternary Paleoecology** **Credits 3**
Examination of the fossil record of the Quaternary including vertebrate, invertebrate, and floral assemblages. Emphasis on paleoenvironmental and paleoclimatological reconstructions. Note(s): This course is crosslisted with GEOL 436. Credit at the 600-level requires additional work.

**GEOL 637 - Paleoclimatology** **Credits 3**
Paleoclimatic history of the Earth, with emphasis on the Neogene and Quaternary Periods. Survey of marine and terrestrial geological records of paleoclimate, including physical sedimentology, geochemistry, and pollen profiles of ice and sediment cores and speleothems. Note(s): This course is crosslisted with GEOL 437. Credit at the 600-level requires additional work.

**GEOL 640 - Volcanology** **Credits 3**
Description and classification of volcanoes, volcanic eruptions, and volcanic deposits. Emphasis on the dynamics of volcanic eruptions, pyroclastic rocks, lava flows, and volcanic hazard assessment. Note(s): This course is crosslisted with GEOL 440. Credit at the 600-level requires additional work.

**GEOL 643 - Plate Tectonics** **Credits 3**
Study of the earth's origin, age, thermal and magnetic history; the dynamics and internal structure of lithospheric plates; the mechanisms and geometric constraints of plate motion; and a review of the motions of plates in the past. Note(s): This course is crosslisted with GEOL 443. Credit at the 600-level requires additional work.

**GEOL 644 - Tectonics of Orogenic Belts** **Credits 3**
Study of crustal deformation and the creation of mountain belts around the world. Emphasis on the comparative structural development of different regions around the globe within the context of plate tectonics. Note(s): This course is crosslisted with GEOL 444. Credit at the 600-level requires additional work.

**GEOL 645 - Geophysical Methods** **Credits 4**
Introduction to geophysical methods, including measurement techniques, rock properties, and interpretation methods using seismology, gravity, magnetics, ground penetrating radar, resistivity and well logs. Note(s): This course is crosslisted with GEOL 445/445L. Credit at the 600-level 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. Note(s): This course is crosslisted with GEOL 445L. Credit at the 600-level requires additional work.

**GEOL 646 - Geologic Applications in Remote Sensing** **Credits 3**
Introduction in the acquisition, processing, and interpretation of remote sensing data. Topics covered include basic mapping concepts, the structure of remote sensing data and analysis, thermal and radar techniques, and classification schemes. Note(s): This course is crosslisted with GEOL 446. Credit at the 600-level 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. Note(s): Credit at the 600-level normally requires additional work.

**GEOL 649 - Geochronology** **Credits 3**
Theoretical foundations and modern analytical techniques used in isotopic dating of rocks. Discussion of applications to specific geologic problems and the thermal significance of isotopic dates. Survey of new dating techniques. Note(s): This course is crosslisted with GEOL 449. Credit at the 600-level requires additional work.

**GEOL 662 - Principles of Stratigraphy and Sedimentation** **Credits 4**
Analysis and application of stratigraphic concepts, and the genesis and classification of sediments. Study of regional stratigraphic patterns and their related sedimentary environments. Note(s): This course is crosslisted with GEOL 462. Credit at the 600-level requires additional work.

**GEOL 671 - Petroleum Geology** **Credits 4**
Origin, migration, accumulation, and geologic distribution of petroleum. Surface, sub-surface and geophysical methods of exploration. Note(s): This course is crosslisted with GEOL 471. Credit at the 600-level requires additional work.

**GEOL 674 - Hydrogeology** **Credits 3**
Factors controlling the occurrence and distribution of water resource, its quality and quantity, methods of exploration and development. Note(s): This course is crosslisted with GEOL 474. Credit at the 600-level requires additional work.

**GEOL 675 - Contaminant Hydrogeology - Hazardous Site Assesment and Remediation** **Credits 3**
Theory and practical application of characterization and cleanup techniques for contaminated sites will be covered, including: understanding different pollutants, environmental law and agency guidance, hydrology and contaminant transport processes, non-invasive techniques, typical and innovative monitoring, sampling procedures, natural and enhanced degradation, and effective and emerging cleanup approaches. Note(s): This course is crosslisted with GEOL 475. Credit at the 600-level requires additional work. Prerequisite(s): GEOL 674

**GEOL 677 - Geology of Metallic Ore Deposits** **Credits 4**
Geology of metallic ore deposits, origin, occurrence, and alteration. Application of ore deposit characteristics to exploration. Note(s): This course is crosslisted with GEOL 477. Credit at the 600-level requires additional work.

**GEOL 678 - Hydrogeochemistry** **Credits 3**
Principles of aquatic geochemistry such as chemical thermodynamics, tableaux, and oxidation reduction and environmental organic geochemistry such as physicochemical properties of organic compounds and air/water/soil exchange of organic compounds for environmental studies. Concepts for practical environmental problems, geochemical modeling, and contaminant transport. Note(s): This course is crosslisted with GEOL 478. Credit at the 600-level requires additional work.

**GEOL 685 - Engineering Geology** **Credits 3**
Application of physical geology to the construction industry. Consideration given to landslide problems, sites for dams, bridges, tunnels and canals; and possible control of erosion and sedimentation by rivers and oceans. Note(s): This course is crosslisted with GEOL 485. Credit at the 600-level requires additional work.

**GEOL 688 - Microtechniques in Geoscience** **Credits 3**
Microanalytical techniques including transmitted and reflected light petrology and petrography, micro-imaging scanning electron microscope (SEM) and electron microprobe (EMP), chemical microanalyses (EMP), fluid inclusion microthermometry, and melt inclusion petrography. Project tailored to the student's interest required. Note(s): This course is crosslisted with GEOL 488. Credit at the 600-level 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. Note(s): Required weekend field trips familiarize students with the local geology. Prerequisite(s): Graduate standing or consent of instructor.

**GEOL 703 - Topics in Advanced Geochemistry** **Credits 3**
This course will cover topics in advanced geochemistry, such as thermodynamics, kinetics, oxidation-reduction, acids and bases, weathering, and other topics of interest. Note(s): May be repeated to a maximum of twelve credits.

**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. Prerequisite(s): 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. Prerequisite(s): 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 3**
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.

**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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Note(s): Six hours laboratory. Prerequisite(s): 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. Prerequisite(s): 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. Note(s): Three hours lecture, three hours laboratory. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): GEOL 672 or equivalent or consent of instructor.

**GEOL 737 - Advanced Paleoclimatology** **Credits 3**
Advanced study in paleoclimatology. Includes orbital (Milankovitch) forcing; origin of millennial-scale climate variability; ice sheet history; records of paleoceanography; tropical monsoon variations, and key records of global and hemispherical paleoclimate, including Antarctica and Greenland ice core records, long speleothem chronologies, and key terrestrial archives of late Quaternary paleoclimate.

**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) Prerequisite(s): Consent of instructor.

**GEOL 742 - Seminar in Volcanology** **Credits 3**
Analysis of current problems, concepts, and research in volcanology and closely related fields. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Note(s): Three hours lecture per week. Prerequisite(s): 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. Note(s): Three hours lecture, three hours laboratory. Prerequisite(s): 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. Note(s): Three hours lecture per week. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Note(s): Three hours lecture and three hours lab. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Note(s): Three hour lecture and three hour lab. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Note(s): Six hours laboratory. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Note(s): 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. Prerequisite(s): Enrollment in the M.S. Program.

**GEOL 789 - Dissertation Research** **Credits 1 – 6**
Supervised research prior to advancement to candidacy in the doctoral program. Note(s): May be repeated, but only two credits can be applied to the student's program. Grading: S/F grading only. Prerequisite(s): 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. Note(s): May be repeated for credit, but only three credits are permitted per instructor unless special permission is received. Prerequisite(s): Consent of instructor.

**GEOL 794 - Directed Readings** **Credits 1 – 3**
Supervised readings on special topics in consultation with a geoscience graduate faculty member. Note(s): May be repeated to a maximum of six credits. Requires consent of student's academic adviser. Grading: S/F grading only. Prerequisite(s): 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. Note(s): Should be taken during first or second semester of graduate program. Prerequisite(s): 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. Note(s): May be repeated to a maximum of six credits. Prerequisite(s): Varies, depending upon the specific topic.

**GEOL 797 - Thesis** **Credits 1 – 6**

Research, analysis, and writing towards completion of thesis and subsequent defense. Note(s): May be repeated, but only six credits applied to the student's program. Grading: S/F grading only. Prerequisite(s): Graduate standing and consent of instructor.

**GEOL 799 - Dissertation** **Credits 3 – 6**

Research analysis and writing toward completion of dissertation and subsequent defense. Note(s): 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. Prerequisite(s): Successful completion of qualifying examination and approval by department.

## School of 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 microscope 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 of Art. 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 online at the school's web site.

*Donald K. Price, Ph.D., Director*
*Andrew J. Andres, Ph.D., Graduate Coordinator*

**Life Sciences Faculty**

**Director**

Price, Donald K.- Full Graduate Faculty Professor; Ph.D., University of Illinois, Champaign. Rebel since 2016.

**Graduate Coordinator**

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

**Graduate Faculty**

Abella, Scott R. - Full Graduate Faculty Assistant Professor; Ph.D., Northern Arizona University, Flagstaff. Rebel since 2015.

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

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

Caberoy, Nora B. - Full Graduate Faculty Assistant Professor; Ph.D., Washington State University, Pullman. Rebel since 2012.

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

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

Han, Mira V. - Full Graduate Faculty Assistant Professor, Ph.D., Indiana University, Bloomington. Rebel since 2013

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

Lee, David V. - Full Graduate Faculty Associate Professor; Ph.D., University of Utah, Salt Lake City. Rebel since 2007.
Raftery, Laurel A. - Full Graduate Faculty Professor; 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 Professor; Ph.D., University of Wisconsin, Madison. Rebel since 2002.
Rodríguez-Robles, Javier A. - Full Graduate Faculty Associate Professor; Ph.D., University of California, Berkeley. Rebel since 2002.
Schiller, Martin R. - Full Graduate Faculty Professor; Ph.D., Utah State University, Logan. Rebel Since 2009.
Schulte, Paul J. - Full Graduate Faculty Associate Professor; Ph.D., University of Washington, Seattle. Rebel since 1990.
Shen, Jeffery Q. - Full Graduate Faculty 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.
Stacy, Elizabeth A. - Full Graduate Faculty Associate Professor; Ph.D., Boston University, Boston. Rebel since 2016.
Stark, Lloyd R. - Full Graduate Faculty Associate Professor; Ph.D., Pennsylvania State University, University Park. Rebel since 1999.
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., Harvard University, Cambridge. Rebel since 2012.
Tseng, Boo S. - Full Graduate Faculty Assistant Professor; Ph.D., Rockefeller University, New York City, Rebel since 2016
Tsourkas, Philippos - Full Graduate Faculty Assistant Professor; Ph.D., Univeristy of California, Berkeley. Rebel since 2012.
Van Breukelen, Frank - Full Graduate Faculty Associate Professor; Ph.D., University of Colorado, Boulder. Rebel since 2002.
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**

Amy, Penny S. Emeritus Professor
Meacham, Susan L. Emeritus Associate Professor; PhD., Virginia Polytechnic and State Univeristy, Blasksburg. UNLV Emeritus 1998-2012.
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.
Starkweather, Peter L. Emeritus Professor; Ph.D., Dartmouth College, Hanover, UNLV Emeritus 1978-2014.
Winokur, Robert Emeritus Associate Professor;
Yousef, Mohamed K. Emeritus Distinguished Professor; Ph.D., University of Missouri. UNLV Emeritus 1968-1994.

## Doctor of Philosophy - Biological Sciences

Plan Description

The School of Life Sciences (SoLS) offers a Ph.D. program in Cell and Molecular Biology, Ecology and Evolutionary Biology, Integrative Physiology, and Microbiology. This degree is research intensive and is designed to prepare students for careers in academia, government, or industry. Students complete a minimum of 60 credit hours from a list of core and approved courses within their section. In addition, students are typically a Teaching Assistant (TA) for at least one semester. It is expected that students will first-author at least one peer-reviewed journal article.

For more information about your program, including your graduate program handbook and learning outcomes please visit the Degree Directory.

**Plan Admission Requirements**

Application deadlines available on the UNLV Graduate College website.

Applications available on the UNLV Graduate College website.

Applications for fall admission that are completed by the posted deadline will be given priority for state-funded graduate assistantships. Admission is based on a combination of criteria that may differ from one year to another, however, most successful applicants have a minimum of a 3.0 undergraduate grade point average (junior and senior years) and score in the upper 50th percentile on all sections of the GRE. Decisions for fall applicants will be made by April 1 if not sooner.

Applications are not considered complete unless they contain:

1. A completed SoLS application form.
2. A completed Graduate College Application with Official transcripts and three Letters of Recommendation.
3. Official GRE score report; subject GREs are not required.
4. A two-page personal statement describing why the applicant wishes to obtain a Ph.D. in biological sciences.

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

Students are accepted into a degree program as described in the Graduate Catalog. The faculty and corresponding sub-disciplines and sub-plans within the described programs are subject to change at any time.

**Plan Requirements**

See Subplan Requirements below.

**Subplan 1 Requirements: Post-Bachelor's - Cellular and Molecular Biology Track**
**Total Credits Required: 60**
**Course Requirements**
**Required Course – Credits: 2**
BIOL 701 - Ethics in Scientific Research

**Core Courses – Credits: 9**
Complete 9 credits from the following list of courses:

BIOL 607 - Molecular Biology

BIOL 625 - Genomics

BIOL 645 - Cell Physiology

CHEM 772 - Nucleic Acid Chemistry

**Didactic Courses – Credits: 9**
Complete 9 credits of advisor-approved didactic courses.

**Seminar Course – Credits: 6**
Complete 6 credits from any combination of the following courses:

BIOL 793A-D - Advanced Topics in Life Sciences

BIOL 796 A-D - Graduate Seminar

**Elective Courses – Credits: 22**
Complete 22 credits of advisor-approved independent study, colloquium, seminar, or didactic courses.

**Dissertation – Credits: 12**
BIOL 799 - Dissertation

**Degree Requirements**

1. Complete a minimum of 60 credit hours beyond the undergraduate degree. At least 24 of these hours (excluding dissertation) must be completed at the 700-level.
2. Dissertation credits may be repeated for credit as needed, but only 12 credits may be counted towards the 60 credit hour minimum graduation requirement.
3. Students must complete the specific didactic course work required. See SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html for specific requirements.
4. Students may request a maximum of 15 graduate credits taken at UNLV prior to admission into SoLS's Graduate Program to be counted towards the 30 credit hour minimum graduation requirement, provided that those credits were not used to fulfill undergraduate requirements and that a minimum grade of "B" (3.00) was earned in each course.
5. Students should register for at least 9 credits each semester if they are receiving financial support from the School; otherwise they must register for at least 6 credits each semester. Students working on their dissertation must register for at least 3 credits each semester (excluding summer) until the Dissertation is completed and given final approval.
6. Students must confer with their Dissertation Advisor prior to enrollment in their first semester. The Advisor will assist with designing an initial graduate degree program (i.e., an outline of the courses that the student will complete for the degree), engage in discussions about possible research directions, and introduce the student to the personnel and resources of the School of Life Sciences.
7. The student must form an Advisory Committee before the department's posted deadline. This Committee will be composed by the Dissertation Advisor (who will serve as the Committee Chair), two members of SoLS's Graduate Faculty, and a Graduate Faculty Representative from UNLV (outside of SoLS). Students are encouraged to include a fifth Committee member who is an expert on the student's field of research. This fifth Committee member can have an academic affiliation outside of UNLV. See SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html for specific requirements. Please see Graduate College policy for committee appointment guidelines.
8. Students must meet with their Advisory Committee at least once every year (i.e., from January to October), and a written report of this meeting must be submitted to SoLS's Graduate Operations Committee by November 1.
9. The Advisory Committee will review the student's past academic background and, taking into consideration the student's research interests, determine his/her definitive graduate degree program.
10. Students must comply with the deadlines indicated in SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html for submitting required paperwork to the Graduate College.
11. Students must take the comprehensive examination before the beginning of their sixth semester of residency in the Graduate Program.
    a. The exam must be held at least three (3) weeks before the last day of instruction of any given term.
    b. The exam will include both a written and an oral component, and will assess whether the student has reached the appropriate level of knowledge and analytical skills necessary for his/her field of study.
    c. The examination is developed or administered by the Doctoral Advisory Committee or an ad hoc Committee composed of Graduate Faculty within the Section to which the student belongs.
    d. See SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html for information on the possible outcomes of the exam. 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.
    e. Failure to pass the retake or meet the requirements of academic probation will result in separation.
12. Doctoral students are advanced to candidacy after passing their comprehensive examination. Specific curricular requirements for each SoLS Section are described in detail in SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html.
13. Each doctoral student should teach for a minimum of two semesters in the undergraduate curriculum of the School of Life Sciences. During that time the student will receive a Graduate Teaching Assistantship.
14. A student will be placed on academic probation if a minimum 3.00 grade point average is not maintained in all work taken as part of the graduate degree program. A grade of "C+" or less in two graduate-level classes will cause a student to be placed on academic probation. Failure to meet the requirements of academic probation will result in separation.
15. The Ph.D. candidate will present a seminar on his/her dissertation work that is open to all interested parties, including the general public. This public seminar will be widely advertised at least seven (7) days before it takes place, and will be followed by an oral defense of the dissertation research before the Advisory Committee and any other Graduate Faculty member who wishes to attend.

**Graduation Requirements**
See Plan Graduation Requirements below.

**Subplan 2 Requirements: Post-Bachelor's - Ecology and Evolutionary Biology Track**
**Total Credits Required: 60**
**Course Requirements**
**Required Course – Credits: 2**
BIOL 701 - Ethics in Scientific Research

**Didactic Courses – Credits: 18**
Complete 18 credits of advisor-approved didactic courses.

**Seminar Course – Credits: 6**
Complete 6 credits from any combination of the following courses:

BIOL 793A-D - Advanced Topics in Life Sciences

BIOL 796 A-D - Graduate Seminar

**Elective Courses – Credits: 22**
Complete 22 credits of advisor-approved independent study, colloquium, seminar, or didactic courses.

**Dissertation – Credits: 12**
BIOL 799 - Dissertation

**Degree Requirements**
1. Complete a minimum of 60 credit hours beyond the undergraduate degree. At least 24 of these hours (excluding dissertation) must be completed at the 700-level.
2. Dissertation credits may be repeated for credit as needed, but only 12 credits may be counted towards the 60 credit hour minimum graduation requirement.
3. Students must complete the specific didactic course work required. See SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html for specific requirements.
4. Students may request a maximum of 15 graduate credits taken at UNLV prior to admission into SoLS's Graduate Program to be counted towards the 30 credit hour minimum graduation requirement, provided that those credits were not used to fulfill undergraduate requirements and that a minimum grade of "B" (3.00) was earned in each course.
5. Students should register for at least 9 credits each semester if they are receiving financial support from the School; otherwise they must register for at least 6 credits each semester. Students working on their dissertation must register for at least 3 credits each semester (excluding summer) until the Dissertation is completed and given final approval.
6. Students must confer with their Dissertation Advisor prior to enrollment in their first semester. The Advisor will assist with designing an initial graduate degree program (i.e., an outline of the courses that the student will complete for the degree), engage in discussions about possible research directions, and introduce the student to the personnel and resources of the School of Life Sciences.
7. The student must form an Advisory Committee before the department's posted deadline. This Committee will be composed by the Dissertation Advisor (who will serve as the Committee Chair), two members of SoLS's Graduate Faculty, and a Graduate Faculty Representative from UNLV (outside of SoLS). Students are encouraged to include a fifth Committee member who is an expert on the student's field of research. This fifth Committee member can have an academic affiliation outside of UNLV. See SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html for specific requirements. Please see Graduate College policy for committee appointment guidelines.
8. Students must meet with their Advisory Committee at least once every year (i.e., from January to October), and a written report of this meeting must be submitted to SoLS's Graduate Operations Committee by November 1.
9. The Advisory Committee will review the student's past academic background and, taking into consideration the student's research interests, determine his/her definitive graduate degree program.
10. Students must comply with the deadlines indicated in SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html for submitting required paperwork to the Graduate College.
11. Students must take the comprehensive examination before the beginning of their sixth semester of residency in the Graduate Program.
    a. The exam must be held at least three (3) weeks before the last day of instruction of any given term.
    b. The exam will include both a written and an oral component, and will assess whether the student has reached the appropriate level of knowledge and analytical skills necessary for his/her field of study.
    c. The examination is developed or administered by the Doctoral Advisory Committee or an ad hoc Committee composed of Graduate Faculty within the Section to which the student belongs.
    d. See SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html for information on the possible outcomes of the exam. 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.
    e. Failure to pass the retake or meet the requirements of academic probation will result in separation.
12. Doctoral students are advanced to candidacy after passing their comprehensive examination. Specific curricular requirements for each SoLS Section are described in detail in SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html.
13. Each doctoral student should teach for a minimum of two semesters in the undergraduate curriculum of the School of Life Sciences. During that time the student will receive a Graduate Teaching Assistantship.
14. A student will be placed on academic probation if a minimum 3.00 grade point average is not maintained in all work taken as part of the graduate degree program. A grade of "C+" or less in two graduate-level classes will cause a student to be placed on academic probation. Failure to meet the requirements of academic probation will result in separation.
15. The Ph.D. candidate will present a seminar on his/her dissertation work that is open to all interested parties, including the general public. This public seminar will be widely advertised at least seven (7) days before it takes place, and will be followed by an oral defense of the

dissertation research before the Advisory Committee and any other Graduate Faculty member who wishes to attend.

**Graduation Requirements**
See Plan Graduation Requirements below.

**Subplan 3 Requirements: Post-Bachelor's - Integrative Physiology Track**
**Total Credits Required: 60**
**Course Requirements**
**Required Course – Credits: 2**
BIOL 701 - Ethics in Scientific Research

**Didactic Courses – Credits: 18**
Complete 18 credits of advisor-approved didactic courses.

**Seminar Course – Credits: 6**
Complete 6 credits from any combination of the following courses:
BIOL 793A-D - Advanced Topics in Life Sciences

BIOL 796 A-D - Graduate Seminar

**Elective Courses – Credits: 22**
Complete 22 credits of advisor-approved independent study, colloquium, seminar, or didactic courses.

**Dissertation – Credits: 12**
BIOL 799 - Dissertation

**Degree Requirements**
1. Complete a minimum of 60 credit hours beyond the undergraduate degree. At least 24 of these hours (excluding dissertation) must be completed at the 700-level.
2. Dissertation credits may be repeated for credit as needed, but only 12 credits may be counted towards the 60 credit hour minimum graduation requirement.
3. Students must complete the specific didactic course work required. See SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html for specific requirements.
4. Students may request a maximum of 15 graduate credits taken at UNLV prior to admission into SoLS's Graduate Program to be counted towards the 30 credit hour minimum graduation requirement, provided that those credits were not used to fulfill undergraduate requirements and that a minimum grade of "B" (3.00) was earned in each course.
5. Students should register for at least 9 credits each semester if they are receiving financial support from the School; otherwise they must register for at least 6 credits each semester. Students working on their dissertation must register for at least 3 credits each semester (excluding summer) until the Dissertation is completed and given final approval.
6. Students must confer with their Dissertation Advisor prior to enrollment in their first semester. The Advisor will assist with designing an initial graduate degree program (i.e., an outline of the courses that the student will complete for the degree), engage in discussions about possible research directions, and introduce the student to the personnel and resources of the School of Life Sciences.
7. The student must form an Advisory Committee before the department's posted deadline. This Committee will be composed by the Dissertation Advisor (who will serve as the Committee Chair), two members of SoLS's Graduate Faculty, and a Graduate Faculty Representative from UNLV (outside of SoLS). Students are encouraged to include a fifth Committee member who is an expert on the student's field of research. This fifth Committee member can have an academic affiliation outside of UNLV. See SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html for specific requirements. Please see Graduate College policy for committee appointment guidelines.
8. Students must meet with their Advisory Committee at least once every year (i.e., from January to October), and a written report of this meeting must be submitted to SoLS's Graduate Operations Committee by November 1.
9. The Advisory Committee will review the student's past academic background and, taking into consideration the student's research interests, determine his/her definitive graduate degree program.
10. Students must comply with the deadlines indicated in SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html for submitting required paperwork to the Graduate College.
11. Students must take the comprehensive examination before the beginning of their sixth semester of residency in the Graduate Program.
    a. The exam must be held at least three (3) weeks before the last day of instruction of any given term.
    b. The exam will include both a written and an oral component, and will assess whether the student has reached the appropriate level of knowledge and analytical skills necessary for his/her field of study.
    c. The examination is developed or administered by the Doctoral Advisory Committee or an ad hoc Committee composed of Graduate Faculty within the Section to which the student belongs.
    d. See SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html for information on the possible outcomes of the exam. 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.
    e. Failure to pass the retake or meet the requirements of academic probation will result in separation.
12. Doctoral students are advanced to candidacy after passing their comprehensive examination. Specific curricular requirements for each SoLS Section are described in detail in SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html.
13. Each doctoral student should teach for a minimum of two semesters in the undergraduate curriculum of the School of Life Sciences. During that time the student will receive a Graduate Teaching Assistantship.
14. A student will be placed on academic probation if a minimum 3.00 grade point average is not maintained in all work taken as part of the graduate degree program. A grade of "C+" or less in two graduate-level classes will cause a student to be placed on academic probation. Failure to meet the requirements of academic probation will result in separation.
15. The Ph.D. candidate will present a seminar on his/her dissertation work that is open to all interested parties, including the general public. This public seminar will be

widely advertised at least seven (7) days before it takes place, and will be followed by an oral defense of the dissertation research before the Advisory Committee and any other Graduate Faculty member who wishes to attend.

**Graduation Requirements**
See Plan Graduation Requirements below.

**Subplan 4 Requirements: Post-Bachelor's - Microbiology Track**
**Total Credits Required: 60**
**Course Requirements**
**Required Course – Credits: 2**
BIOL 701 - Ethics in Scientific Research

**Core Courses – Credits: 3**
Complete 3 credits from the following list of courses:
BIOL 609 - Virology

BIOL 618 - Microbial Ecology

BIOL 653 - Immunology

BIOL 660 - Microbial Physiology

BIOL 664 - Bacterial Pathogenesis

BIOL 685 - Microbial Genetics

**Didactic Courses – Credits: 15**
Complete 15 credits of advisor-approved didactic courses.

**Seminar Course – Credits: 6**
Complete 6 credits from any combination of the following courses:

BIOL 793A-D - Advanced Topics in Life Sciences

BIOL 796 A-D - Graduate Seminar

**Elective Courses – Credits: 22**
Complete 22 credits of advisor-approved independent study, colloquium, seminar, or didactic courses.

**Dissertation – Credits: 12**
BIOL 799 - Dissertation

**Degree Requirements**
1. Complete a minimum of 60 credit hours beyond the undergraduate degree. At least 24 of these hours (excluding dissertation) must be completed at the 700-level.
2. Dissertation credits may be repeated for credit as needed, but only 12 credits may be counted towards the 60 credit hour minimum graduation requirement.
3. Students must complete the specific didactic course work required. See SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html for specific requirements.
4. Students may request a maximum of 15 graduate credits taken at UNLV prior to admission into SoLS's Graduate Program to be counted towards the 30 credit hour minimum graduation requirement, provided that those credits were not used to fulfill undergraduate requirements and that a minimum grade of "B" (3.00) was earned in each course.
5. Students should register for at least 9 credits each semester if they are receiving financial support from the School; otherwise they must register for at least 6 credits each semester. Students working on their dissertation must register for at least 3 credits each semester (excluding summer) until the Dissertation is completed and given final approval.
6. Students must confer with their Dissertation Advisor prior to enrollment in their first semester. The Advisor will assist with designing an initial graduate degree program (i.e., an outline of the courses that the student will complete for the degree), engage in discussions about possible research directions, and introduce the student to the personnel and resources of the School of Life Sciences.
7. The student must form an Advisory Committee before the department's posted deadline. This Committee will be composed by the Dissertation Advisor (who will serve as the Committee Chair), two members of SoLS's Graduate Faculty, and a Graduate Faculty Representative from UNLV (outside of SoLS). Students are encouraged to include a fifth Committee member who is an expert on the student's field of research. This fifth Committee member can have an academic affiliation outside of UNLV. See SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html for specific requirements. Please see Graduate College policy for committee appointment guidelines.
8. Students must meet with their Advisory Committee at least once every year (i.e., from January to October), and a written report of this meeting must be submitted to SoLS's Graduate Operations Committee by November 1.
9. The Advisory Committee will review the student's past academic background and, taking into consideration the student's research interests, determine his/her definitive graduate degree program.
10. Students must comply with the deadlines indicated in SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html for submitting required paperwork to the Graduate College.
11. Students must take the comprehensive examination before the beginning of their sixth semester of residency in the Graduate Program.
    a. The exam must be held at least three (3) weeks before the last day of instruction of any given term.
    b. The exam will include both a written and an oral component, and will assess whether the student has reached the appropriate level of knowledge and analytical skills necessary for his/her field of study.
    c. The examination is developed or administered by the Doctoral Advisory Committee or an ad hoc Committee composed of Graduate Faculty within the Section to which the student belongs.
    d. See SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html for information on the possible outcomes of the exam. 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.
    e. Failure to pass the retake or meet the requirements of academic probation will result in separation.
12. Doctoral students are advanced to candidacy after passing their comprehensive examination. Specific curricular requirements for each SoLS Section are described in detail in SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html.

13. Each doctoral student should teach for a minimum of two semesters in the undergraduate curriculum of the School of Life Sciences. During that time the student will receive a Graduate Teaching Assistantship.
14. A student will be placed on academic probation if a minimum 3.00 grade point average is not maintained in all work taken as part of the graduate degree program. A grade of "C+" or less in two graduate-level classes will cause a student to be placed on academic probation. Failure to meet the requirements of academic probation will result in separation.
15. The Ph.D. candidate will present a seminar on his/her dissertation work that is open to all interested parties, including the general public. This public seminar will be widely advertised at least seven (7) days before it takes place, and will be followed by an oral defense of the dissertation research before the Advisory Committee and any other Graduate Faculty member who wishes to attend.

**Graduation Requirements**
See Plan Graduation Requirements below.

**Subplan 5 Requirements: Post-Master's Track**
**Total Credits Required: 30**
**Course Requirements**
**Required Course – Credits: 2**
BIOL 701 - Ethics in Scientific Research

**Seminar Course – Credits: 6**
Complete 6 credits from any combination of the following courses:

BIOL 793A-D - Advanced Topics in Life Sciences

BIOL 796 A-D - Graduate Seminar

**Didactic Courses – Credits: 10**
Complete 10 credits of advisor-approved didactic courses.

**Dissertation – Credits: 12**
BIOL 799 - Dissertation

**Degree Requirements**
1. Complete a minimum of 30 credit hours when entering the program with a master's degree from another institution. At least 9 of these hours must be completed at the 700-level.
2. Dissertation may be repeated for credit as needed, but only 12 credits may be counted towards the 30 credit hour minimum graduation requirement.
3. Students must complete the didactic course work required by the Section (e.g., Ecology and Evolutionary Biology, Cell and Molecular Biology, Microbiology, and Integrative Physiology) to which they belong. See SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html for specific requirements.
4. Students may request a maximum of 15 graduate credits taken at UNLV prior to admission into SoLS's Graduate Program to be counted towards the 30 credit hour minimum graduation requirement, provided that those credits were not used to fulfill undergraduate requirements and that a minimum grade of "B" (3.00) was earned in each course.
5. Students should register for at least nine (9) credits each semester if they are receiving financial support from the School; otherwise they must register for at least six (6) credits each semester. Students working on their dissertation must register for at least three (3) credits each semester (excluding summer) until the Dissertation is completed and given final approval.
6. Students must confer with their Dissertation Advisor prior to enrollment in their first semester. The Advisor will assist with designing an initial graduate degree program (i.e., an outline of the courses that the student will complete for the degree), engage in discussions about possible research directions, and introduce the student to the personnel and resources of the School of Life Sciences.
7. The student must form an Advisory Committee before the department's posted deadline. This Committee will be composed by the Dissertation Advisor (who will serve as the Committee Chair), two members of SoLS's Graduate Faculty, and a Graduate Faculty Representative from UNLV (outside of SoLS). Students are encouraged to include a fifth Committee member who is an expert on the student's field of research. This fifth Committee member can have an academic affiliation outside of UNLV. See SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html for specific requirements. Please see Graduate College policy for committee appointment guidelines.
8. Students must meet with their Advisory Committee at least once every year (i.e., from January to October), and a written report of this meeting must be submitted to SoLS's Graduate Operations Committee by November 1.
9. The Advisory Committee will review the student's past academic background and, taking into consideration the student's research interests, determine his/her definitive graduate degree program.
10. Students must comply with the deadlines indicated in SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html for submitting required paperwork to the Graduate College.
11. Students must take the comprehensive examination before the beginning of their sixth semester of residency in the Graduate Program.
    1. The exam must be held at least three (3) weeks before the last day of instruction of any given term.
    2. The exam will include both a written and an oral component, and will assess whether the student has reached the appropriate level of knowledge and analytical skills necessary for his/her field of study.
    3. The examination is developed or administered by the Doctoral Advisory Committee or an ad hoc Committee composed of Graduate Faculty within the Section to which the student belongs.
    4. See SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html for information on the possible outcomes of the exam. 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.
    5. Failure to pass the retake or meet the requirements of academic probation will result in separation.

12. Doctoral students are advanced to candidacy after passing their comprehensive examination. Specific curricular requirements for each SoLS Section are described in detail in SoLS's Graduate Student Handbook http://sols.unlv.edu/current.html.
13. Each doctoral student should teach for a minimum of two semesters in the undergraduate curriculum of the School of Life Sciences. During that time the student will receive a Graduate Teaching Assistantship.
14. A student will be placed on academic probation if a minimum 3.00 grade point average is not maintained in all work taken as part of the graduate degree program. A grade of "C+" or less in two graduate-level classes will cause a student to be placed on academic probation. Failure to meet the requirements of academic probation will result in separation.
15. The Ph.D. candidate will present a seminar on his/her dissertation work that is open to all interested parties, including the general public. This public seminar will be widely advertised at least seven (7) days before it takes place, and will be followed by an oral defense of the dissertation research before the Advisory Committee and any other Graduate Faculty member who wishes to attend.

**Graduation Requirements**
See Plan Graduation Requirements below.

**Plan Graduation Requirements**
1. 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.
2. 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.
3. 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.

## Master of Science - Biological Sciences

**Plan Description**
The School of Life Sciences offers an M.S. program with concentrations in Cell and Molecular Biology, Ecology and Evolutionary Biology, Integrative Physiology, and Microbiology. This degree is less research intensive than the Ph.D. and is designed to prepare students for a diverse set of science-related careers.

For more information about your program, including your graduate program handbook and learning outcomes please visit the Degree Directory.

**Plan Admission Requirements**
Application deadlines available on the UNLV Graduate College website.

Applications available on the UNLV Graduate College website.

Applications for fall admission that are completed by the posted deadline will be given priority for state-funded graduate assistantships. Admission is based on a combination of criteria that may differ from one year to another, however, most successful applicants have a minimum of a 3.0 undergraduate grade point average (junior and senior years) and score in the upper 50th percentile on all sections of the GRE. Decisions for fall applicants will be made by April 1 if not sooner.

Please note that the M.S. and Ph.D. degrees from the School of Life Sciences (SoLS) are research degrees. Applicants must look through the faculty web pages to identify one or more potential mentors as part of their application. They are required to contact these faculty directly regarding the possibility of joining their lab.

Applications are not considered complete unless they contain:

1. A completed SoLS application form.
2. A completed Graduate College Application with Official transcripts and two Letters of Recommendation.
3. Official GRE score report; subject GREs are not required.
4. A two-page personal statement describing why the applicant wishes to obtain the MS degree.

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

Students are accepted into a degree program as described in the Graduate Catalog. The faculty and corresponding sub-disciplines and sub-plans within the described programs are subject to change at any time.

**Plan Requirements**
See Subplan Requirements below.

**Subplan 1 Requirements: Cellular and Molecular Biology Track**
**Total Credits Required: 30**
**Course Requirements**
**Required Course – Credits: 2**
BIOL 701 - Ethics in Scientific Research

**Core Courses – Credits: 6**
Complete 6 credits from the following list of courses:
BIOL 607 - Molecular Biology

BIOL 625 - Genomics

BIOL 645 - Cell Physiology

CHEM 772 - Nucleic Acid Chemistry

**Didactic Course – Credits: 3**
Complete 3 credits of an advisor-approved didactic course.

**Seminar Course – Credits: 6**
Complete 6 credits from any combination of the following courses:
BIOL 793A-D - Advanced Topics in Life Sciences

BIOL 796 A-D - Graduate Seminar

**Elective Courses – Credits: 7**
Complete 7 credits of advisor-approved independent study, colloquium, seminar, core, or didactic courses.

**Thesis – Credits: 6**
BIOL 797 - Thesis

**Degree Requirements**
See Plan Degree Requirements below.

**Graduation Requirements**
See Plan Graduation Requirements below.

**Subplan 2 Requirements: Ecology and Evolutionary Biology Track**
**Total Credits Required: 30**
**Course Requirements**
**Required Course – Credits: 2**
BIOL 701 - Ethics in Scientific Research

**Didactic Courses – Credits: 9**
Complete 9 credits of advisor-approved didactic courses.

**Seminar Course – Credits: 6**
Complete 6 credits from any combination of the following courses:
BIOL 793A-D - Advanced Topics in Life Sciences

BIOL 796 A-D - Graduate Seminar

**Elective Courses – Credits: 7**
Complete 7 credits advisor-approved independent study, colloquium, seminar, or didactic courses.

**Thesis – Credits: 6**
BIOL 797 - Thesis

**Degree Requirements**
See Plan Degree Requirements below.

**Graduation Requirements**
See Plan Graduation Requirements below.

**Subplan 3 Requirements: Inegrative Physiology Track**
**Total Credits Required: 30**
**Course Requirements**
**Required Course – Credits: 2**
BIOL 701 - Ethics in Scientific Research

**Didactic Courses – Credits: 12**
Complete 12 credits of advisor-approved didactic courses.

**Seminar Course – Credits: 6**
Complete 6 credits from any combination of the following courses:
BIOL 793A-D - Advanced Topics in Life Sciences

BIOL 796 A-D - Graduate Seminar

**Elective Courses – Credits: 4**
Complete 4 credits of advisor-approved independent study, colloquium, seminar, or didactic courses.

**Thesis – Credits: 6**
BIOL 797 - Thesis

**Degree Requirements**
See Plan Degree Requirements below.

**Graduation Requirements**
See Plan Graduation Requirements below.

**Subplan 4 Requirements: Microbiology Track**
**Total Credits Required: 30**
**Course Requirements**
**Required Course – Credits: 2**
BIOL 701 - Ethics in Scientific Research

**Core Courses – Credits: 3**
Complete one of following courses:
BIOL 609 - Virology

BIOL 618 - Microbial Ecology

BIOL 653 - Immunology

BIOL 660 - Microbial Physiology

BIOL 664 - Bacterial Pathogenesis

BIOL 685 - Microbial Genetics

**Didactic Courses – Credits: 6**
Complete 6 credits of advisor-approved didactic courses.

**Seminar Course – Credits: 6**
Complete 6 credits from any combination of the following courses:
BIOL 793A-D - Advanced Topics in Life Sciences

BIOL 796 A-D - Graduate Seminar

**Elective Courses – Credits: 7**
Complete 7 credits of independent study, colloquium, seminar, core, or didactic courses.

**Thesis – Credits: 6**
BIOL 797 - Thesis

**Degree Requirements**
See Plan Degree Requirements below.

**Graduation Requirements**
See Plan Graduation Requirements below.

**Plan Degree Requirements**
1. Complete a minimum of 30 credit hours beyond the undergraduate degree. At least 18 of these hours must be completed at the 700-level.
2. Students may request a maximum of 15 graduate credits taken at UNLV prior to admission into SoLS's Graduate Program to be counted towards the 30 credit hour minimum graduation requirement, provided that those credits were not used to fulfill undergraduate requirements and that a minimum grade of "B" (3.00) was earned in each course.
3. At least 50 percent of the total credits required to complete the Master's degree must be earned at UNLV after admission into the Graduate Program.

4. Students should register for at least nine (9) credits each semester if they are receiving financial support from SoLS; otherwise they must register for at least six (6) credits each semester. Students working on their thesis must register for at least three (3) credits each semester (excluding summer) until the Master's Thesis is completed and given final approval.
5. Students must confer with their Thesis Advisor prior to enrollment in their first semester. The Advisor will assist with designing an initial graduate degree program (i.e., an outline of the courses that the student will complete for the degree), engage in discussions about possible research directions, and introduce the student to the personnel and resources of the School of Life Sciences.
6. Students must form an Advisory Committee before the department's posted deadline. This Committee will be composed by the Thesis Advisor (who will serve as the Committee Chair), two members of SoLS's Graduate Faculty, and a Graduate Faculty Representative from UNLV (but outside of SoLS). An additional committee member may be added at the student and department's discretion. Please see Graduate College policy for committee appointment guidelines.
7. Students must meet with their Advisory Committee at least once every year (i.e., from January to October), and a written report of this meeting must be submitted to SoLS's Graduate Operations Committee by November 1.
8. The Advisory Committee will review the student's past academic background and, taking into consideration the student's research interests, determine his/her definitive graduate degree program.
9. Students must comply with the deadlines indicated in SoLS's Graduate Student Handbook http://sols.unlv.edu/gradhandbook.html for submitting required paperwork to the Graduate College.
10. A student will be placed on academic probation if a minimum 3.00 grade point average is not maintained in all work taken as part of the graduate degree program. A grade of "C+" or less in two graduate-level classes will cause a student to be placed on academic probation.
11. The M.S. candidate will present a seminar on his/her thesis work that is open to all interested parties, including the general public. This public seminar will be widely advertised at least seven (7) days before it takes place, and will be followed by an oral defense of the thesis research before the Advisory Committee and any other Graduate Faculty member who wishes to attend.
12. Students are expected to complete all the requirements for the Master's degree in 2-3 years.

**Plan Graduation Requirements**

1. 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.
1. 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.
2. 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.

**BIOL 602 - Great Biological Discoveries** **Credits 3**
Students will critically examine ~25 of the most important biological discoveries of all time and learn to examine data, develop hypotheses, identify valid conclusions, challenge interpretations of results, and discuss significance. The course will help students identify the origins of biological fields and develop a "big picture" view of biology. Prerequisite(s): Consent of instructor.

**BIOL 603 - Restoration Ecology** **Credits 3**
The science and practice of repairing ecosystems that have been damaged or destroyed; including determining reference conditions, restoration practices across biomes, and challenges to restoration during an era of global change in climate, disturbance, and biological invasions. Note(s): This course is crosslisted with BIOL 403. Credit at the 600-level requires additional work. Prerequisite(s): Consent of instructor.

**BIOL 604 - Principles of Neurobiology** **Credits 3**
Note(s): This course is crosslisted with BIOL 404. Credit at the 600 level requires additional work.

**BIOL 607 - Molecular Biology** **Credits 3**
Introductory molecular biology. Study of genes and their activities at the molecular level, including transcription, translation, DNA replication, and recombination. Concepts of molecular biology presented along with experimental strategies and data the led to those concepts. Note(s): This course is crosslisted with BIOL 405. Credit at the 600 level requires additional work.

**BIOL 609 - Virology**
Systematic examination of animal, plant, and bacterial viruses including their structure and genome organization, their reproduction and assembly, and their effects on host organisms. Note(s): This course is crosslisted with BIOL 409. Credit at the 600-level 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. Note(s): Credit at the 600 level normally requires additional work.

**BIOL 613 - Introduction to Scientific Writing** **Credits 2**
Scientific writing for those intending to publish manuscripts, technical reports, or academic papers in the sciences. Writing techniques, published literature, and student writing examples are presented and evaluated. Students will improve their writing skills and learn to critique published writing samples. This course is crosslisted with BIOL 413. Credit at the 600-level requires additional work.

**BIOL 616 - Bioinformatics** **Credits 3**
This class covers basic principles in bioinformatics, as well as Perl programming, algorithms, databases, and use of many bioinformatics resources. In class "laboratory" exercises reinforce these topics with hands-on activities and individual/group learning exercises. The class emphasizes a conceptual and practical understanding of bioinformatics applied to biological systems at the molecular, cellular, and organismal level. Prerequisite(s): Consent of instructor.

**BIOL 618 - Microbial Ecology**
Study of microbes as individuals, populations, and communities in freshwater, marine, and terrestrial environments. Topics such as nutrient cycling, biodegradation, and biotechnology discussed from an ecological standpoint. Note(s): This course is crosslisted with BIOL 418. Credit at the 600-level requires additional work.

**BIOL 622 - Taxonomy of Vascular Plants**
Study of the evolutionary relationships of the principal orders, families and genera; systems of classification; collection and identification of local flora. Note(s): This course is crosslisted with BIOL 422. Credit at the 600-level requires additional work.

**BIOL 625 - Genomics**
Study of the sequencing, assembling and annotating of genomes. Examination of new approaches that integrate genetics, molecular biology, and computer sciences to answer biological questions in novel ways. Applications of genomics, proteomic and bioinformatic technologies in medical researches. Note(s): This course is crosslisted with BIOL 425. Credit at the 600-level requires additional work.

**BIOL 626 - Plant Anatomy**
Study of the basic structure of plant organs and tissues, particularly with regard to relationships between structure and function. Note(s): This course is crosslisted with BIOL 426. Credit at the 600-level requires additional work.

**BIOL 628 - Biometry** **Credits 3**
Analysis of large data sets, statistical hypothesis testing, and experimental design. Examples drawn from molecular biology (e.g. microarrays, RNA-Seq), ecology, systems biology, and population genetics. Introduction to programming in the R programming language. Note(s): This course is crosslisted with BIOL 428. Coursework at the graduate level requires additional work. Prerequisite(s): Consent of instructor.

## BIOL 631 - Ichthyology
Study of biology of fishes, including morphology, physiology, ecology, and evolution. Emphasis on local fish, field work with state and federal agency biologists. Note(s): This course is crosslisted with BIOL 431. Credit at the 600-level requires additional work.

**BIOL 632 - Herpetology**
Introduction to various aspects of the ecology, behavior, and evolution of recent amphibians and non-avian reptiles. In the laboratory students will learn diagnostic characteristics, some functional attributes, and aspects of the natural history of recent amphibians and non-avian reptiles, particularly of species from southwestern North America. Note(s): This course is crosslisted with BIOL 432. Credit at the 600-level requires additional work.

**BIOL 633 - Ornithology**
Principles of avian biology and evolution. Note(s): This course is crosslisted with BIOL 433. Credit at the 600-level requires additional work.

**BIOL 634 - Mammalogy** **Credits 4**
Study of mammalian biology, evolution, and ecology, with attention to issues in mammal conservation biology. Three hours lecture and three hours laboratory with possible weekend and overnight field trips. Note(s): This course is crosslisted with BIOL 434. Credit at the 600 level requires additional work.

**BIOL 635 - Forest Ecology** **Credits 3**
Principles of the ecology and conservation of forest ecosystems; tree species traits, forest development, and disturbance effects on forests; evolutionary processes in forest change; animal and microorganism use of forest habitats and influences on forests; effects of fire, forest pests, and global change on forest ecology and biodiversity. Note(s): This course is crosslisted with BIOL 435. Credit at the 600-level requires additional work. Prerequisite(s): Undergraduate degree in biology.

**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. Note(s): This course is crosslisted with BIOL 438. Credit at the 600-level requires additional work. Prerequisite(s): CHEM 121, CHEM 122, and BIOL 197 or equivalents.

**BIOL 640 - Mammalian Physiology** **Credits 3**
Principles of mammalian physiology, normal functioning of mammalian body as a whole, and interrelationships of organs and organ systems. Emphasis on physiological processes and their interrelationships. Note(s): This course is crosslisted with BIOL 440. Credit at the 600-level requires additional work. Prerequisite(s): Departmental consent.

**BIOL 641 - Field Ecology**
Introduction to ecological research. Weekly field projects emphasize population biology, interactions among species, and ecosystem processes. Note(s): This course is crosslisted with BIOL 441. Credit at the 600-level requires additional work.

**BIOL 642 - Principles of Plant Physiology** **Credits 4**
Introduction to the basic physiological processes in plants: metabolism, nutrition, growth, and development. Note(s): This course is crosslisted with BIOL 442. Credit at the 600 level requires additional work.

**BIOL 644 - Principles of Plant Ecology** **Credits 3**
Introduction to the ecology of wild plants, particularly structure, ecology of populations, interactions of plants with their environment and other organisms, and survey of the major global vegetation types. Note(s): This course is crosslisted with BIOL 444. Credit at the 600 level requires additional work.

**BIOL 645 - Cell Physiology** **Credits 3**
Cell physiology provides an understanding of the basic processes of eukaryotic cells and their relationship to cellular ultrastructure. Note(s): This course is crosslisted with BIOL 445. Credit at the 600 level requires additional work. Prerequisite(s): Consent of instructor.

**BIOL 647 - Comparative Animal Physiology** **Credits 4**
Comparative physiology provides a detailed understanding of the diverse array of physiological systems evolved to allow animals to function in various environments. The comparative approach is used to understand physiological adaptations to various environments and the evolution of physiological systems. Note(s): This course is crosslisted with BIOL 447. Credit at the 600 level requires additional work.

**BIOL 648 - Endocrinology** **Credits 3**
Survey of the structure and function of vertebrate endocrine systems, with emphasis on the biochemical basis of hormone action and the role of cell communication in endocrine physiology. Note(s): This course is crosslisted with BIOL 414. Credit at the 600 level 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. Note(s): This course is crosslisted with BIOL 451. Credit at the 600-level requires additional work. Prerequisite(s): Biology degree or consent of instructor. Corequisite(s): BIOL 655

**BIOL 653 - Immunology** **Credits 3**
Study of the immune response, cell-mediated and humoral. Topics include the diversity of antibodies and antigen receptors, evolution of immunity, cell-cell interactions, importance of major histocompatibility complex immune regulation, and immunity to microorganisms. Note(s): This course is crosslisted with BIOL 453. Credit at the 600-level 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. Prerequisite(s): Biology degree or consent of instructor. Corequisite(s): BIOL 651

**BIOL 658 - Stem Cells and Regeneration Biology** **Credits 3**
A survey of research literature in regeneration biology and stem cells across the organismal, tissue, and molecular levels. Our focus is on understanding tissue regeneration through model organism studies (invertebrates and vertebrates). Topics include stem cells, wound healing, organogenesis, and age dependent-regeneration, with discussions of applicability towards promoting human regenerative repair.

**BIOL 660 - Microbial Physiology** **Credits 4**
Exploration of the major aspects of microbial physiology, including structure and growth of bacteria, generation of ATP and intermediary metabolism, synthesis of macromolecules and cellular components, and coordination of intracellular activities. Note(s): This course is crosslisted with BIOL 460. Credit at the 600 level requires additional work.

**BIOL 664 - Bacterial Pathogenesis** **Credits 3**
Addresses the molecular mechanisms by which bacterial pathogens cause disease. Basic principles of bacterial pathogenesis will be considered before a survey of bacterial pathogens and their specific virulence factors is conducted. Includes aspects of bacterial genetics, physiology, immunology, and the cell biology of host-parasite interactions. Note(s): This course is crosslisted with BIOL 464. Credit at the 600 level requires additional work. Prerequisite(s): BIOL 351 or equivalent microbiology class.

**BIOL 665 - Vertebrate Embryology** **Credits 4**
Development of vertebrates, with emphasis on amphibians, birds, and mammals. Considerations of gametogenesis, fertilization, cleavage, early morphogenesis, and organogenesis included. Note(s): This course is crosslisted with BIOL 465. Credit at the 600-level requires additional work.

**BIOL 666 - Developmental Biology** **Credits 3**
Developmental biology from the perspectives of evolutionary biology, experimental embryology, cell biology, and genetics, emphasizing triploblastic animals. Mechanisms of patterning, tissue organization, genetic basis of morphological changes, developmental genetics of model species, and extension of these principles to selected problems in current biomedical research. Prerequisite(s): BIOL 304 and BIOL 445, or permission of instructor.

**BIOL 668 - Histology** **Credits 4**
Microscopic structure and function of vertebrate tissues with emphasis on mammals. Note(s): This course is crosslisted with BIOL 468. Credit at the 600-level requires additional work.

**BIOL 670 - Topics in Applied Microbiology** **Credits 3**
Applications may include bioremediation, food, agriculture, pharmaceuticals, vaccine development, water treatment, or genetic engineering. Presentation and discussion of current literature. Topics published in the class schedule. Maximum of two different topics may be selected for a total of six credits. Note(s): This course is crosslisted with BIOL 470. Credit at the 600 level requires additional work.

**BIOL 671 - Aquatic Ecology** **Credits 3**
Principles of aquatic ecology including physical, chemical and biotic attributes - and their interactions - relating to both freshwater and marine systems. Note(s): This course is crosslisted with BIOL 471. Credit at the 600 level requires additional work.

**BIOL 672 - Limnology** **Credits 4**
Note(s): Credit at the 600 level requires additional work.

**BIOL 678 - Genetics and Cell Biology of Cancer** **Credits 3**
An exploration of the genetic controls that go arwy during carcinogenesis, tumorigenesis, and metastasis leading to cancer. A mixture of formal lectures, student presentations, and class discussions are employed. Course is crosslisted with BIOL 478. Credit at the 600-level requires additional work. Note(s): Course is crosslisted with BIOL 478. Credit at the 600-level requires additional work. Prerequisite(s): Permission of instructor.

**BIOL 680 - Introduction to Biological Modeling** **Credits 3**
Introduction to the modeling of biological systems and processes through the use of computers. Note(s): This course is crosslisted with BIOL 480. Credit at the 600-level requires additional work.

**BIOL 685 - Microbial Genetics** **Credits 4**
Examines genetics of prokaryotic microorganisms, including induction of mutations and selection of mutants, alternative processes of genetic exchange and gene mapping, and gene organization and regulation. Note(s): This course is crosslisted with BIOL 485. Credit at the 600-level requires additional work.

**BIOL 687 - Principles of Systematics** **Credits 3**
Principles and applications of methods used to reconstruct history and biotic diversity among genes, species, and higher taxa. Considers several approaches to tree construction and significance of phylogenetic history within the context of evolution, biogeography, and conservation biology. Note(s): This course is crosslisted with BIOL 487. Credit at the 600-level requires additional work.

**BIOL 689 - Developmental Genetics** **Credits 3**
Topics in molecular genetics of developmental processes explored through current literature. Note(s): This course is crosslisted with BIOL 489. Credit at the 600 level requires additional work.

**BIOL 690 - Biogeography** **Credits 3**
Study of distributional patterns of plant and animal groups, including consideration of theories and principles, derived from a variety of disciplines, related to those patterns. Note(s): This course is crosslisted with BIOL 490. Credit at the 600 level requires additional work.

**BIOL 699 - RNA Biology** **Credits 3**
Comprehensive survey designed to cover multiple types and biological roles of RNA. Specific topics include role of RNAs in the regulation of important cellular and physiological processes, and how alteration of RNA functions could lead to human genetic diseases as well as RNA-based therapies. Note(s): This course is crosslisted with BIOL 469. Coursework at the 600-level requires additional work.

**BIOL 701 - Ethics in Scientific Research** **Credits 2**
Examination of ethical issues in scientific research, including research design, planning, and support; data manipulation and accessibility; publication practices and authorship; peer review; and scientific misconduct. Prerequisite(s): Graduate standing or consent of instructor

**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. Prerequisite(s): 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. Note(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Note(s): Three hours laboratory. Prerequisite(s): 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). Note(s): May be repeated to a maximum of nine credits. Prerequisite(s): 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. Note(s): May be repeated to a maximum of six credits. Prerequisite(s): 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. Prerequisite(s): 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 Prerequisite(s): 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. Prerequisite(s): 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. Note(s): Three hours of lecture and discussion. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): BIO 340 or consent of instructor.

**BIOL 786 - Bioenergetics** **Credits 3**
Review of primary and secondary productivity and associated topics dealing with ecosystem energetics. Note(s): Four hours laboratory. Prerequisite(s): 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. Note(s): May be repeated to a maximum of three credits. Grading: S/F grading only. Prerequisite(s): 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. Note(s): May be repeated to a maximum of nine credits. Prerequisite(s): 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). Note(s): May be repeated to a maximum of nine credits. Prerequisite(s): 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. Note(s): May be repeated to a maximum of ten credits. Prerequisite(s): 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. Note(s): Topics announced with each offering. May be repeated to a maximum of twelve credits. Prerequisite(s): 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. Note(s): May be repeated to a maximum of six credits. Prerequisite(s): 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. Note(s): Three to nine laboratory hours per week. Prerequisite(s): 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). Note(s): May be repeated to a maximum of ten credits. Prerequisite(s): Graduate standing in biology.

**BIOL 797 - Thesis** **Credits 3 – 6**
Note(s): 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. Note(s): May be repeated but a maximum of only 18 credits may be applied to the degree program. Grading: S/F grading only. Prerequisite(s): Graduate standing in the Biology Ph.D. program and consent of instructor.

**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. Note(s): 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. Note(s): 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**
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. Note(s): 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.

## 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, 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, and 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.

*Zhijian Wu, Ph.D., Chair*
*Kaushik Ghosh, Ph.D., Graduate Coordinator*

**Mathematical Sciences Faculty**

**Chair**

Wu, Zhijian- Full Graduate Faculty Professor; B.S., China University of Geosciences; M.S., Peking University; Ph.D., Washington University. Rebel since 2015.

**Graduate Coordinator**

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

**Graduate Faculty**

Amei, Amei - Full Graduate Faculty Associate 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 at Urbana-Champaign. Rebel since 1991.

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

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

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.

Catlin, Sandra - Full Graduate Faculty Associate Professor; B.A., University of California, Berkeley; M.S., Ph.D., University of Washington. Rebel since 1997.

Chen, Le Assistant Professor; B.S., Dalian Jiaotong University; M.S., Tsinghua University; Ph.D., École Polytechnique Fédérale de Lausanne. Rebel since 2017.

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. Rebel since 1995.

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

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 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, China; 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 Associate Professor; B.S., University of Novi Sad; Ph.D., University of Pittsburgh. Rebel since 2007.

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

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

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

Savatorova, Viktoria Assistant Professor; B.S., Moscow Institute of Physics and Technology; M.S., Ph.D., Moscow Engineering Institute (MEPhI); D.Sc., Higher Attestation Commission of Ministry of Education and Science, Russsia. Rebel since 2014.

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 Associate 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.

Verma, Sadanand- Full Graduate Faculty Professor; B.S., Patna University, India; M.S., Bihar University, India; M.S., Ph.D., Wayne State University. Rebel since 1967.

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

Yang, Hongtao - Full Graduate Faculty Associate 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., University of Oklahoma; 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.

## 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.

For more information about your program, including your graduate program handbook and learning outcomes, please visit the Degree Directory.

**Plan Admission Requirements**

Application deadlines available on the UNLV Graduate College website.

Applications available on the UNLV Graduate College website.

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:

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

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

1. Copies of all official transcripts sent to the Graduate College.
2. At least three letters of recommendation from persons familiar with the applicant's academic record and potential for advanced study in mathematical sciences.
3. The official GRE General Test score
4. A completed application for Graduate Assistantship, if interested.

5. 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.

Students are accepted into a degree program as described in the Graduate Catalog. The faculty and corresponding sub-disciplines and sub-plans within the described programs are subject to change at any time.

**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**
Select an advisor approved 2-semester sequence from one of the following:
MAT 717 - Analytical Solution Methods for Partial Differential Equations, I

MAT 718 - Analytical Solution Methods for Partial Differential Equations, II

OR

MAT 729 - Partial Differential Equations I

MAT 730 - Partial Differential Equations II

OR

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**
Select an advisor approved 2-semester sequence from one of the following:
MAT 717 - Analytical Solution Methods for Partial Differential Equations, I

MAT 718 - Analytical Solution Methods for Partial Differential Equations, II

OR

MAT 729 - Partial Differential Equations I

MAT 730 - Partial Differential Equations II

OR

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**
1. 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.
2. 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.
3. A student must enroll in a minimum of 18 credits of Dissertation.
4. 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.
5. 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. 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.
   b. Doctoral students must pass the Qualifying Examination within three years.
   c. The Qualifying Examination consists of two parts, corresponding to Required Courses Part 1 & Part2.
   d. 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.

i. 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.
ii. A post-master's track student who fails the Qualifying Examination a second time will be separated from the program.

6. 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.
7. 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.
   a. 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.
   b. 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.
   c. 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.
   d. 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.
8. 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.
9. 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.
10. 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.
11. 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.
12. 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.
13. 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**

1. 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.
2. 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.
3. 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.

## Master of Science - Mathematical Sciences

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

The concentrations in Pure Math, Applied Math and Applied 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.

For more information about your program, including your graduate program handbook and learning outcomes please visit the Degree Directory.

**Plan Admission Requirements**
Application deadlines available on the UNLV Graduate College website.

Applications available on the UNLV Graduate College website.

1. All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements.
2. 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.
3. Submit application materials to both the Graduate College and the Department of Mathematical Sciences.
   a. Firstly, applicants must submit to the Graduate College the following materials:
      i. A completed online application
      ii. Submit official transcripts from all post-secondary institutions attended
   b. Secondly, applicants must submit to the Department of Mathematical Sciences the following materials:
      i. Copies of all transcripts sent to the Graduate College
      ii. At least two letters of recommendation from persons familiar with the applicant's academic record and potential for advanced study in mathematical sciences
      iii. 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
      iv. A completed online Graduate Assistantship application, if interested

Students are accepted into a degree program as described in the Graduate Catalog. The faculty and corresponding sub-disciplines and sub-plans within the described programs are subject to change at any time.

**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**
1. Students must complete a minimum of 33 credit hours with a minimum GPA of 3.00.
2. Of the 33 required credits, 27 must be coursework. Of those 27 coursework credits, at least 18 must be 700-level.
3. 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.
4. 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**

1. 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.
2. 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.
3. 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**

1. Students must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
2. Of the 30 required credits, at least 18 must be 700-level.
3. 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.
4. 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**

1. 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.
2. 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**

1. Students must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
2. Of the 33 required credits, 27 must be coursework. Of those 27 coursework credits, at least 18 must be 700-level.
3. 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.
4. 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**

1. 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.

2. 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.
3. 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

1. Students must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
2. Of the 30 required credits, at least 18 must be 700-level.
3. 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.
4. 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**
1. 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.
2. The student must successfully complete a final comprehensive examination.
2. 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.
3. 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 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**
STA 791 - Thesis

**Degree Requirements**
1. Students must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
2. Of the 33 required credits, 27 must be coursework. Of those 27 coursework credits, at least 18 must be 700-level.
3. 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.
4. 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**
1. 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.
2. 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.
3. 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**
1. Students must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
2. Of the 30 required credits, 27 must be coursework. Of those 27 coursework credits, at least 18 must be 700-level.
3. 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.
4. 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**
1. 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.
2. 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**
1. Students must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
2. Of the 30 required credits, 27 must be coursework. Of those 27 coursework credits, at least 15 must be 700-level.
3. 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.

4. 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**
1. 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.
2. 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**
1. Students must complete a minimum of 30 credit hours with a minimum GPA of 3.00.
2. Of the 30 required credits, 27 must be coursework. Of those 27 coursework credits, at least 15 must be 700-level.
3. 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.
4. 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**
1. 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.
2. The student must pass a final comprehensive examination.

**Plan Graduation Requirements**
Refer to your subplan for Graduation Requirements.

**MAT 651 - Foundations of Mathematics I** **Credits 3**
Introduction to logic, set algebra and Boolean algebra, with applications to the theory of computing machines. Note(s): This course is crosslisted with MAT 451. Credit at the 600-level requires additional work. 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** **Credits 3**
Formalization, proofs, and models of quantificational logic; axiomatics; application to mathematical theories, including set theory. Note(s): This course is crosslisted with MAT 452. Credit at the 600-level requires additional work. 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** **Credits 3**
Sets, functions, groups, quotient groups, homomorphism theorems, Abelian groups, rings, polynomial rings, division rings, Euclidean domains, fields and vector spaces. Note(s): This course is crosslisted with MATH 453. Credit at the 600-level requires additional work. 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** **Credits 3**
Sets, functions, groups, quotient groups, homomorphism theorems, Abelian groups, rings, polynomial rings, division rings, Euclidean domains, fields and vector spaces. Note(s): This course is crosslisted with MATH 454. Credit at the 600-level requires additional work. 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** **Credits 3**
Topics include divisibility, arithmetic functions, congruences, quadratic residues, primitive roots, Diophantine equations, continued fractions, algebraic numbers, and partitions. Note(s): This course is crosslisted with MATH 455. Credit at the 600-level requires additional work. 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** **Credits 3**
Topics include divisibility, arithmetic functions, congruences, quadratic residues, primitive roots, Diophantine equations, continued fractions, algebraic numbers, and partitions. Note(s): This course is crosslisted with MATH 456. Credit at the 600-level requires additional work. 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** **Credits 3**
Topics include finite and infinite sets, axiomatic study of real numbers, topology of Cartesian spaces, sequences of functions, continuous functions, differentiation of functions of one variable. Note(s): This course is crosslisted with MATH 457. Credit at the 600-level requires additional work. 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** **Credits 3**
Topics include uniform continuity and fixed point theorems, sequences of continuous functions, approximation theorems, Riemann-Stieltjes integral, uniform convergence and infinite integrals, series of functions, differentiation in Rn. Note(s): This course is crosslisted with MATH 458. Credit at the 600-level requires additional work. 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** **Credits 3**
Complex numbers, analytic functions, contour integration, conformal mapping, applications. Note(s): This course is crosslisted with MAT 459. Credit at the 600-level requires additional work.

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** **Credits 3**
Fundamental concepts of probability; random variables, binomial, Poisson, normal, chi-square, T, F and other distributions; transformations of random variables; conditional and marginal distributions; central limit theorem and concepts associated with the field of statistics. Note(s): This course is crosslisted with MATH 461. Credit at the 600-level requires additional work. 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** **Credits 3**
Markov chains and jump processes, elements of queuing theory, stationary stochastic processes, the Wiener process and stochastic differential equations. Note(s): This course is crosslisted with MATH 462. Credit at the 600-level requires additional work. 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 Credits 3**
Rigorous mathematical treatment of orthogonal matrices, Gram-Schmidt method, Q-R factorization, least-squares fits, eigenvalues and eigenvectors, linear difference equations, systems of linear differential equations, unitary similarities, Schur's theorem, discrete Markov processes, power method, quadratic forms, singular value decompositions, pseudo-inverse, systems of linear inequalities, and simplex method. Note(s): This course is crosslisted with MATH 463. Credit at the 600-level requires additional work. 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 Credits 3**
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. Note(s): 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 Credits 3**
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. Note(s): 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 Credits 3**
Introduction to finite element method with computer applications to engineering continuum problems such as thermodynamics, solid/fluid mechanics. Topics include variational formulation of boundary value problems, natural and essential boundary conditions, discretization of domain based on rectangular, triangular, tethedral and other elements, with linear, quadratic and higher order polynomial approximations. Note(s): This course is crosslisted with MATH 468. Credit at the 600-level requires additional work. 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 Credits 3**
Graph models, covering circuits, graph colorings, trees and searching, general counting methods for arrangements and selections, generating functions, recurrence relations, and inclusion-exclusion. Note(s): This course is crosslisted with MATH 469. Credit at the 600-level requires additional work. 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 Credits 3**
Advanced topics in combinatorics. Topics to be selected by the instructor. Note(s): This course is crosslisted with MATH 470. Credit at the 600-level requires additional work. 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 Credits 3**
Study of advanced geometrical topics using the methods of proof of elementary geometry. Note(s): This course is crosslisted with MATH 480. Credit at the 600-level requires additional work. 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 Credits 3**
Topological spaces, nets and filters, compactness, continuous functions, product and quotient spaces, introduction to algebraic topology. Note(s): This course is crosslisted with MATH 483. Credit at the 600-level requires additional work. 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 Credits 3**
Topological spaces, nets and filters, compactness, continuous functions, product and quotient spaces, introduction to algebraic topology. Note(s): This course is crosslisted with MATH 484. Credit at the 600-level requires additional work. 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 DifferentialEquationsCredits 3**
Method of separation of variables, Fourier series, divergence theorem and Green's identities, equations of mathematical physics, initial and initial boundary value problems, well-posedness, heat conduction in a thin rod, vibrations of a string, Laplace's equation, solution of the Dirichlet problem for a disc and for a rectangle. Note(s): This course is crosslisted with MATH 488. Credit at the 600-level requires additional work. 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 Credits 3**
Graduate-level course in advanced topics of mathematics, depending upon the interest of faculty and students. Note(s): This course is crosslisted with MATH 489. Credit at the 600-level requires additional work. 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.May be repeated to a maximum of six credits.

**MAT 690 - Independent Study** **Credits 3**
Library research and reports on topics of mathematical interest. Note(s): This course is crosslisted with MAT 499. Credit at the 600-level requires additional work. 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): MAT 658

**MAT 708 - Real Analysis II** **Credits 3**
Theory of measure, integration and differentiation: Banach spaces; Hilbert spaces; spaces of continuous functions. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): MAT 487/687, or MAT 717, or consent of instructor.

**MAT 719 - Graph Theory I** **Credits 3**
Advanced graduate level study of the topics: adjacency and incidence matrices, nonseparable graphs, trees, connectivity, edge-connectivity, Eulerian graphs, Hamiltonian graphs, line graphs, strong digraphs, groups and graphs, Cayley color graph, Reconstruction Problem, planar graphs, graph embeddings, crossing number, genus, and maximum genus. Prerequisite(s): MAT 670 or consent of instructor.

**MAT 720 - Graph Theory II** **Credits 3**
Advanced graduate level study of the topics: graph and map colorings, chromatic polynomials, matchings and independence in graphs, factorizations and decomposition, domination, extremal graph theory, and Ramsey theory. Prerequisite(s): MAT 719

**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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): MAT 684 or consent of instructor.

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

**MAT 736 - Lightning Radiative Transfer I** **Credits 3**
The analysis of lightning events: cloud-to-ground and intra-cloud discharges, ground and space detection of lightning. Prerequisite(s): MAT 729 or consent of instructor.

**MAT 737 - Lightning Radiative Transfer II** **Credits 3**
Diffusion propagation of Lightning, transport phenomena, and applications of advanced Twersky scattering through clouds.

**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. Prerequisite(s): 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. Prerequisite(s): MAT 718 and MAT 740 or consent of instructor.

**MAT 751 - Topics in Foundations of Mathematics** **Credits 3**
Topics selected by the instructor. Note(s): May be repeated for credit with the consent of the mathematics department. Except under special circumstances, total credits limited to six credits. Prerequisite(s): MAT 701, MAT 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. Prerequisite(s): 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. Prerequisite(s): MAT 703-704 or consent of instructor.

**MAT 755 - Topics in Algebra** **Credits 3**
Topics selected by the instructor. Note(s): May be repeated for credit with the consent of the mathematics department. Except under special circumstances, total credits limited to six. Prerequisite(s): MAT 703, MAT 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. Prerequisite(s): MAT 653 and 654, or equivalent.

**MAT 757 - Topics in Analysis** **Credits 3**
Topics selected by the instructor. Note(s): May be repeated for credit with the consent of the mathematics department. Except under special circumstances, total credits limited to six. Prerequisite(s): MAT 707, MAT 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. Prerequisite(s): 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. Prerequisite(s): 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. Note(s): Topics selected by instructor.Three hours lecture, two hours laboratory. Prerequisite(s): MAT 666

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

**MAT 767 - Topics in Numerical Analysis** **Credits 3**
Topics selected by the instructor. Note(s): May be repeated for credit with the consent of the mathematics department. Except under special circumstances, total credits limited to six. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): MATH 428 or 658 or consent of instructor.

**MAT 776 - Topics in Applied Mathematics** **Credits 3**
Students are presented with very advanced and important topics of applied mathematics that are not given in other graduate courses. The topics would depend on the particular instructor and the particular graduate students. Topics may be repeated but a maximum of 6 credits can apply to program. Note(s): May be repeated to a maximum of 6 credits. Prerequisite(s): MAT 659 or MAT 687 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) Prerequisite(s): Knowledge of UNIX, FORTRAN, and previous course on numerical methods. Graduate standing.

**MAT 781 - Advanced Graduate Workshop in Foundations** **Credits 3**
Students are assigned advanced material to read, lecture on, and present to the class. Two years of 700-level mathematics in Foundations are required. The workshop is very time intensive, with additional weekly meetings required. Students will present polished lectures, based on their workshop presentations, at the Department's Set Theory Seminar. Note(s): May be repeated to a maximum of six credits. Prerequisite(s): MAT 751

**MAT 783 - Topics in Topology** **Credits 3**
Topics selected by the instructor. Note(s): May be repeated for credit with the consent of the mathematics department. Except under special circumstances, total credits limited to six credits. Prerequisite(s): 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. Note(s): 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. Note(s): 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**
Research, analysis, and writing towards completion of thesis and subsequent defense. Note(s): 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. Note(s): 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. Note(s): May be repeated any number of times, but no more than three credits will count towards degree requirements. Grading: S/F grading only. Prerequisite(s): Consent of instructor.

**MAT 799 - Dissertation** **Credits 3-6**
Research analysis and writing toward completion of dissertation and subsequent defense. A minimum of 18 dissertation credits is required for a degree program. Dissertation may be repeated but only a maximum of 36 credits may be used in students degree program. Grading: S/F grading only Prerequisite(s): Successful completion of qualifying examination and approval by department.

**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. Prerequisite(s): STA 667 or consent of instructor.

**STA 663 - Applied Statistics for Engineers** **Credits 3**
Elementary probability, commonly used discrete and continuous probability distributions, estimation and hypothesis testing, categorical data testing, regression, model building, analysis of variance, product and system reliability and engineering applications, and quality control. Note(s): This course is crosslisted with STAT 463. Credit at the 600-level requires additional work.

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 I** **Credits 3**
Introduction to probability theory, random variables and their probability distributions, common discrete probability models, common continuous probability models, multivariate probability distributions, functions of random variables, methods of transformations, limiting distributions, and limit theorems. Note(s): This course is crosslisted with STAT 467. Credit at the 600-level requires additional work. 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 668 - Introduction to Mathematical Statistics II** **Credits 3**
Sample and sampling distributions, estimation theory, evaluation of estimation, unbiased estimation, sufficiency, information inequality, methods of estimation, method of moments, maximum likelihood estimation, Bayesian estimation, confidence intervals, hypotheses testing, uniformly most powerful tests, likelihood ratio tests and related procedures, linear models, and non-parametric models. Prerequisite(s): STA 667 or consent of instructor.

**STA 669 - Environmental Statistics I: Univariate Methods** **Credits 3**
Principles of environmental sampling, testing for outliers, tests for normality, transformations for normality, sample size determinations, analysis of censored data, estimation of background contaminations, tolerance and confidence limits, calibration problem, quality control charts for data quality assessment of environmental data, statistical issues in environmental remediation, and probability of hot spot detection. Usage of statistical software packages. Note(s): This course is crosslisted with STAT 469. Credit at the 600-level requires additional work. 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** **Credits 3**
Graduate course in advanced topics in statistics, depending upon the interest of faculty and students. Note(s): This course is crosslisted with STAT 489. Credit at the 600-level requires additional work. 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** **Credits 1-3**
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. Note(s): 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** **Credits 3**
Frequency distributions, descriptive statistics, elementary probability; Bernoulli, binomial, and normal distributions; statistical sampling, estimation, and hypothesis testing. Note(s): This course is crosslisted with STAT 491. Credit at the 600-level requires additional work. 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** **Credits 3**
Chi-square tests for goodness-of-fit and independence, simple and multiple linear regression, designing an experiment (analysis of variance), multiple comparisons. Note(s): This course is crosslisted with STAT 492. Credit at the 600-level requires additional work. 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** **Credits 3**
Line fitting; multiple linear and curvilinear regression models; variable selection techniques and examination of residuals, estimation, testing, and prediction; simple, multiple, and partial correlation. Note(s): This course is crosslisted with STAT 493. Credit at the 600-level requires additional work. 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** **Credits 3**
Survey of nonparametric procedures with emphasis on application; binomial, Mann-Whitney, Wilcoxon, Kruskal-Wallis, Friedman, Kolmogorov-Smironov, and chi-square tests; measures of association; regression. Comparisons with parametric techniques. Note(s): This course is crosslisted with STAT 495. Credit at the 600-level requires additional work. 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): MAT 657

**STA 751 - Spatial Statistics** **Credits 3**
Stochastic process, first and second order stationarity, intrinsic hypothesis, models of spatial dependence, different forms of Kriging — Ordinary Kriging, Universal Kriging, Probability Kriging, bicubic splines, conditional simulation. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): STA 767

**STA 777 - Survival Analysis** **Credits 3**
Statistical methods for modeling and analysis of time to event data. Topics include survival function and hazard function; Kaplan-Meier estimator; Greenwood's formula; log-rank and weighted log-rank tests; regression modeling of survival data including proportional hazards model and accelerated failure time model; competing risks. Prerequisite(s): STA 768

**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. Note(s): 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. Note(s): May be repeated to a maximum of six credits with consent of the department.

**STA 791 - Thesis** **Credits 3 – 6**
Research, analysis, and writing towards completion of thesis and subsequent defense. Note(s): 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. Note(s): 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. Note(s): 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. Prerequisite(s): Successful completion of qualifying examination and approval by department.

## Physics & Astronomy

The Department of Physics and Astronomy 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 Department of Physics and Astronomy 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*
*Victor Kwong, Ph.D., Graduate Coordinator*

**Physics and Astronomy Faculty**
**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**

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.

**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.

Kim, Eunja - Associate Graduate Faculty Assistant Research Professor; MS, Ph.D., Jeonbuk National University, Korea. Rebel since 2003.

Kumar, Ravhi - Full Graduate Faculty Associate Research Professor; Ph.D., Anna University, Chennai. Rebel since 2001.

Lavina, Barbara - Full Graduate Faculty Associate Research Professor; MS, Ph.D., University of Pedova, Italy. Rebel since 2006.

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

Martin, Rebecca - Full Graduate Faculty Assistant Professor; B.A., MS, Churchill College, Cambridge Universsity UK, Ph.D., Institute of Astronomuy and Jesus College, Cambridge University, UK. Rebel since 2015.

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 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.

Salamat, Ashkan - Full Graduate Faculty Assistant Professor; MS, Imperial College, UK, Ph.D., University College London, UK. Rebel since 2015.

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 since 1988.

Steffen, Jason - Full Graduate Faculty Assistant Professor; B.S., Weber State University, UT, MS, University of Washington, WA, Ph.D., Univerisity of Washington, WA. Rebel since 2015.

Wang, Liping - Full Graduate Faculty Associate Research Faculty; BS, University of Science and Technology, China, MS, Ph.D., University of Michigan, MI. Rebel since 2011.

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.

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

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

## 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.

For more information about your program, including your graduate program handbook and learning outcomes please visit the Degree Directory.

**Plan Admission Requirements**
Application deadlines available on the UNLV Graduate College website.

Applications available on the UNLV Graduate College website.

1. Applicants must have an undergraduate degree or a Masters degree in Physics, Astronomy or related area.
2. 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.
3. 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.
4. 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.

Students are accepted into a degree program as described in the Graduate Catalog. The faculty and corresponding sub-disciplines and sub-plans within the described programs are subject to change at any time.

**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**
1. The student must complete a minimum of 60 credits.
2. 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.
3. 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.
4. A dissertation of high quality consisting of significant original research.
5. 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**
1. 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.
2. The total number of Required, Theory, Astronomy, and Seminar courses will be determined in consultation with the student's advisor.
3. 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.
4. 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.
5. A dissertation of high quality consisting of significant original research.
6. 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**
1. 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.
2. 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.
3. 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.

For more information about your program, including your graduate program handbook and learning outcomes, please visit the Degree Directory.

**Plan Admission Requirements**
Application deadlines available on the UNLV Graduate College website.

Applications available on the UNLV Graduate College website.

1. 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.
2. 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.
3. All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements.

Students are accepted into a degree program as described in the Graduate Catalog. The faculty and corresponding sub-disciplines and sub-plans within the described programs are subject to change at any time.

**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 712 - Electromagnetic Theory II

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**
1. Students must complete a minimum of 60 credits.
2. 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.
3. 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.
4. Each student's advisory committee will carry out an annual review of the student's progress.
5. Course work taken outside the Physics & Astronomy Department must have departmental approval.
6. 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.
7. 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.
8. 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**
1. 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.
2. The total number of Required Courses and Graduate Seminar Courses will be determined in consultation with the student's advisor.
3. 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.
4. 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.
5. Each student's advisory committee will carry out an annual review of the student's progress.
6. Course work taken outside the Physics & Astronomy Department must have departmental approval.
7. 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.
8. 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.
9. 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**
1. 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.
2. 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.
3. 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.

## 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.

For more information about your program, including your graduate program handbook and learning outcomes please visit the Degree Directory.

**Plan Admission Requirements**
Application deadlines available on the UNLV Graduate College website.

Applications available on the UNLV Graduate College website.

1. Applicants must have an undergraduate degree in Physics, Astronomy or other related area.
2. 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.
3. Applicants must have completed 18 semester credits of upper-division physics.
4. All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements.

Students are accepted into a degree program as described in the Graduate Catalog. The faculty and corresponding sub-disciplines and sub-plans within the described programs are subject to change at any time.

**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**
1. Complete a minimum of 30 graduate credits.
2. Complete a minimum of 15 credits (excluding thesis) in 700-level astronomy or physics courses.
3. A GPA of 3.00 or better is required in all course work which is part of the degree program.
4. 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**
1. 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.
2. The student must successfully complete and defend a thesis by the posted deadline. The defense must be advertised and is open to the public.
3. 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**
1. Complete a minimum of 30 graduate level credits in physics, astronomy, or related fields (excluding graduate seminar).
2. Complete at least 15 credits of 700-level astronomy or physics courses.
3. A GPA of 3.00 or better in all course work which is part of the degree program.
4. 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.
5. Satisfactory performance on an astronomy qualifying examination on graduate astronomy knowledge at the master's level.

**Graduation Requirements**
1. 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.
2. The student must pass a qualifying examination.

**Plan Graduation Requirements**
Refer to your subplan for Graduation Requirements.

## 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.

For more information about your program including your graduate program handbook and learning outcomes please visit the Degree Directory.

**Plan Admission Requirements**
Application deadlines available on the UNLV Graduate College website.

Applications available on the UNLV Graduate College website.

1. 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.
2. The applicant must have completed 18 semester credits of upper-division undergraduate physics.
3. All domestic and international applicants must review and follow the Graduate College Admission and Registration Requirements.

Students are accepted into a degree program as described in the Graduate Catalog. The faculty and corresponding sub-disciplines and sub-plans within the described programs are subject to change at any time.

**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**
1. A minimum of 30 graduate credits is required, including a minimum of 15 credits (excluding thesis) in 700-level courses.
2. A GPA of 3.00 or better is required in all course work which is part of the degree program.
3. 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**
1. 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.
2. The student must successfully complete and defend a thesis by the posted deadline. The defense must be advertised and is open to the public.
3. 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**
PHYS 711 - Electromagnetic Theory I

PHYS 721 - Quantum Theory I

**Core Courses – Credits: 6**
Complete two additional advisor approved 700 level PHYS courses.

**Elective Courses – Credits: 18**
Complete 18 Credits of 600- or 700-level AST or PHYS courses, or other advisor approved graduate courses.

**Degree Requirements**
1. Complete a minimum of 30 graduate level credits in physics, astronomy, or related fields (excluding graduate seminar).
2. Complete at least 15 credits of 700-level astronomy or physics courses.
3. A GPA of 3.00 or better in all course work which is part of the degree program.
4. 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.
5. Satisfactory performance on a physics qualifying examination on graduate physics knowledge at the master's level.

**Graduation Requirements**
1. 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.
2. 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**

**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. Prerequisite(s): Graduate standing.

**AST 713 - Astrophysics I** **Credits 3**
Laws of physics applied to astrophysical situations. Note(s): Major topics include solar physics, element synthesis, stellar evolution, end states of stars. Prerequisite(s): Graduate standing.

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

**PHYS 604 - Computational Techniques in Physics** **Credits 3**
Application of numerical methods to simulation of physical systems, including topics in classical mechanics, electrostatics, quantum mechanics, scattering, nonlinear dynamics and chaos. Note(s): This course is crosslisted wtih PHYS 404. Credit at the 600-level requires additional work.

**PHYS 614 - Intermediate Laboratory II** **Credits 3**
Further experimental investigations of phenomena in classical and modern physics. Emphasis on problem solving, experimental technique, data analysis, and independent work. Students encouraged to alter or extend the experiments and engage in projects. Note(s): This course is crosslisted with PHYS 414. Credit at the 600-level requires additional work.

**PHYS 622 - Electricity and Magnetism** **Credits 3**
Electrostatics, magnetic fields, and electromagnetism. Maxwell's equations, theory of metallic conduction, motion of charged particles, radiation. Note(s): This course is crosslisted wtih PHYS 422. Credit at the 600-level requires additional work.

**PHYS 624 - Mechanics** **Credits 3**
Newtonian mechanics. Mathematical formulation of the dynamics of a particle and systems of particles, including applications to atomic physics. Mechanics of continuous media using Fourier series. Introduction to generalized coordinates and the methods of Lagrange and Hamilton. Note(s): This course is crosslisted with PHYS 424. Credit at the 600-level requires additional work.

**PHYS 626 - Physics of Solids** **Credits 3**
Structure of crystalline solids. Mechanical, thermal, and electric properties of conducting and non-conducting solids. Note(s): This course is crosslisted with PHYS 426. Credit at the 600-level requires additional work.

**PHYS 631 - Nuclear and Elementary Particle Physics** **Credits 3**
Survey of basic nuclear concepts and structure. Interactions between nuclear radiations and matter, nuclear reactions and decay, nuclear force, sub-atomic structure and models, symmetries and conservation laws. Note(s): This course is crosslisted with PHYS 431. Credit at the 600-level requires additional work.

**PHYS 641 - Mathematical Physics I** **Credits 3**
Application of selected mathematical techniques to problems in physics. Note(s): This course is crosslisted with PHYS 441. Credit at the 600-level requires additional work.

**PHYS 642 - Mathematical Physics II** **Credits 3**
Application of selected mathematical techniques to problems in physics. Note(s): This course is crosslisted with PHYS 642. Credit at the 600-level requires additional work.

**PHYS 651 - Modern Scientific Instrumentation** **Credits 3**
Electronics for scientists, including circuit design and construction using analog and digital integrated circuits. Introduction to machining, glassblowing, and fabrication techniques. Note(s): This course is crosslisted with PHYS 451. Credit at the 600-level requires additional work.

**PHYS 661 - Light and Physical Optics** **Credits 3**
Survey of geometric optics and optical instruments. Selected topics in physical optics including interference, diffraction and polarization, with applications; the nature of light. Note(s): This course is crosslisted with PHYS 461. Credit at the 600-level requires additional work.

**PHYS 662 - Modern Optics and Photonics** **Credits 3**
Laser principles and applications. Non-linear optics, image formation, optical transfer function, and Fourier optics. Introduction to quantum optics. Note(s): This course is crosslisted with PHYS 462. Credit at the 600-level requires additional work.

**PHYS 667 - Thermodynamics** **Credits 3**
Fundamentals of thermodynamics, including equations of state, laws of thermodynamics, and entropy. Principles and methods of temperature measurement, calorimetry and heat transfer. Note(s): This course is crosslisted with PHYS 467. Credit at the 600-level requires additional work.

**PHYS 668 - Statistical Mechanics** **Credits 3**
Principles and applications of statistical mechanics. Quantum statistics of ideal gas and simple solids. Transport theory, irreversible processes and fluctuations. Note(s): This course is crosslisted wtih PHYS 668. Credit at the 600-level requires additional work.

**PHYS 681 - Quantum Mechanics I** **Credits 3**
Introduction to the Schroedinger Equation and the interpretation of its solutions, the uncertainty principles, one-dimensional problems, harmonic oscillator, angular momentum, the hydrogen atom. Note(s): This course is crosslisted with PHYS 481. Credit at the 600-level requires additional work.

**PHYS 682 - Quantum Mechanics II** **Credits 3**
Introduction to the matrix formulation of quantum mechanics, spin, coupling of angular momenta and applications. Time dependent perturbation theory and approximation methods and techniques discussed. Note(s): This course is crosslisted with PHYS 482. Credit at the 600-level requires additional work.

**PHYS 683 - Special Topics in Physics** **Credits 3**
Special topics in physics such as, but not limited to, relativity, plasma physics, hydrodynamics, and particle physics. Note(s): This course is crosslisted with PHYS 483. Credit at the 600-level requires additional work.

**PHYS 685 - Condensed Matter Physics** **Credits 3**
Properties of condensed matters and their applications in materials science. Structures of classical and quantum liquids. Correlations in lower dimensional systems. Localization and magnetism. Superconductivity and superfluidity. Polymers and liquid crystals. Note(s): This course is crosslisted with PHYS 485. Credit at the 600 level-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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Prerequisite(s): 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. Note(s): May be repeated for credit in different fields to a maximum of 12 credits. Prerequisite(s): 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. Note(s): May be repeated to a maximum of six credits. Prerequisite(s): Prior conference with instructor.

**PHYS 781 - Thesis Research** **Credits 1**
Research leading to master's level program prospectus. Note(s): May be repeated but only one credit can be applied to the student's program. Grading: S/F grading only. Prerequisite(s): Enrollment in the M.S. Program.

**PHYS 782 - Dissertation Research** **Credits 1**
Supervised research prior to advancement to candidacy in the doctoral program. Note(s): 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. Prerequisite(s): 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. Note(s): 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. Prerequisite(s): Graduate standing.

**PHYS 797 - Thesis** **Credits 3 – 6**
Research, analysis, and writing towards completion of thesis and subsequent defense. Note(s): 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. Note(s): May be repeated. A minimum of 18 credits required for the degree. Prerequisite(s): Qualifying exam and approval by department.

## Water Resources Management

The Water Resources Management (WRM) graduate program 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 with a desire to address water-related issues enter the WRM program from a wide variety of undergraduate degree programs (e.g., natural sciences, physical sciences, engineering, business, social sciences, education, liberal arts, environmental studies, architecture, etc.). After admission to the WRM program, students then work with their faculty advising committee to design a course of study that will strengthen their understanding of the hydrologic sciences and water management, while also developing relevant technical skills.

The Water Resources Management graduate program is housed in the UNLV College of Sciences. Faculty participation in the WRM program is by application, and not restricted to the College of Sciences. Student research projects may involve faculty members from other colleges on the UNLV campus, the Desert Research Institute, or government agencies (e.g., U.S. Environmental Protection Agency, the U.S. Geological Survey, Southern Nevada Water Authority, U.S. Bureau of Reclamation, etc.).

*Michael Nicholl, Ph.D., Director, Graduate Coordinator*

**Water Resources Management Faculty**
**Director and Graduate Coordinator**

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

Graduate Faculty Faculty participating in the Water Resources Management Graduate Program (WRM) are affiliated with several different colleges, departments, and centers at UNLV, and elsewhere within the Nevada System of Higher Education. Active research scientists affiliated with governmental agencies or private industry 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.

## 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.

For more information about your program including your graduate program handbook and learning outcomes please visit the Degree Directory.

**Plan Admission Requirements**

Application deadlines available on the UNLV Graduate College website.

Applications available on the UNLV Graduate College website.

Applicants to the program must hold a B.S. or B.A. degree in the physical, natural or social sciences, engineering, 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.

Students are accepted into a degree program as described in the Graduate Catalog. The faculty and corresponding sub-disciplines and sub-plans within the described programs are subject to change at any time.

**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 hydrologic science courses.

**Additional Science Course – Credits: 3**
Complete 3 credits of advisor-approved science, mathematics or engineering courses (BIOL, CEE, CHEM, GEOL, MAT, ME, PHYS, STA prefixes).

**Administrative Courses – Credits: 9**
Complete 9 credits of advisor-approved management, public administration, economics, law, or political science courses (ECO, ENV, HIST, LAW, MGT, MIS, PSC, PUA prefixes).

**Elective Courses – Credits: 6**
Complete 6 credits of advisor-approved BIOL, CEE, CHEM, ECO, ENV, GEOL, HIST, LAW, MAT, ME, MGT, MIS, PHYS, PSC, PUA, or STA courses.

**Thesis – Credits: 6**
WRM 798 - Thesis

**Degree Requirements**
1. Completion of a minimum of 33 credit hours with a minimum GPA of 3.00.
2. A minimum of 15 credit hours must be in 700-level courses.
3. 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 to achieve their research and educational goals.
4. In consultation with his/her advisor, a student will organize a thesis committee of at least three members of the WRM Graduate Faculty. In addition, a fourth member from outside the WRM Graduate Faculty, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and WRM Program Director's discretion. Please see Graduate College policy for committee appointment guidelines.
5. 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.
6. There will be a final examination that will include a comprehensive oral examination.

**Graduation Requirements**
1. 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.
2. 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.
3. 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 hydrologic science courses.

**Additional Science Courses – Credits: 6**
Complete 6 credits of advisor-approved science, mathematics or engineering courses (BIOL, CEE, CHEM, GEOL, MAT, ME, PHYS, STA prefixes).

**Administrative Courses – Credits: 12**
Complete 12 credits of advisor-approved management, public administration, economics, law, or political science courses (ECO, ENV, HIST, LAW, MGT, MIS, PSC, PUA prefixes).

**Elective Courses – Credits: 6**
Complete 6 credits of advisor-approved BIOL, CEE, CHEM, ECO, ENV, GEOL, HIST, LAW, MAT, ME, MGT, MIS, PHYS, PSC, PUA, or STA courses.

**Professional Paper – Credits: 3**
WRM 796 - Professional Paper in WRM

**Degree Requirements**
1. Completion of a minimum of 36 credit hours with a minimum GPA of 3.00.
2. A minimum of 15 credit hours must be in 700-level courses.
3. 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 to achieve their research and educational goals.
4. In consultation with his/her advisor, a student will organize a committee of at least three members of the WRM Graduate Faculty. In addition, a fourth member from outside the WRM Graduate Faculty, known as the Graduate College Representative, must be appointed. An additional committee member may be added at the student and WRM Program Director's discretion. Please see Graduate College policy for committee appointment guidelines.
5. 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.

6. There will be a final examination that will include a comprehensive oral examination.

**Graduation Requirements**

1. 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.
2. The student must successfully complete and defend a professional paper.

**Plan Graduation Requirements**

Refer to your subplan for Graduation Requirements.

**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. Prerequisite(s): 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. Note(s): May be repeated to a maximum of nine credits. Prerequisite(s): Consent of instructor.

**WRM 791 - Independent Study** **Credits 1 – 3**

Review of recent literature in a specialized area related to water resources. Note(s): May be repeated to a maximum of four credits. Prerequisite(s): Consent of instructor.

**WRM 796 - Professional Paper in WRM** **Credits 1-6**

Professional paper preparation, including review of literature or similar research effort. Note(s): May be repeated to a maximum of three credits. Not permitted for students pursuing the M.S. Thesis option. Prerequisite(s): Consent of instructor.

**WRM 798 - Thesis** **Credits 1 – 3**

Enrollment by consent of research director only. Note(s): May be repeated for credit with cumulative maximum of six credits allowed toward degree program. Grading: S/F grading only.