Department of
Mining & Geological
Engineering

GUIDE TO GRADUATE STUDIES

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THE UNIVERSITY OF ARIZONA.
Arizona's First University.

www.mge.arizona.edu

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1. INTRODUCTION

The University of Arizona is one of the top-ranked research universities in the United States, boasting very strong mining engineering and economic geology programs as well as top-ranked colleges of public health, medicine, law, business, social sciences, science, and engineering. The Mining and Geological Engineering Department (MGE) is at the forefront of research in the areas of mine management, feasibility studies, sustainable development, geomechanics, information technology, health and safety, industrial hygiene, mineral processing, extractive/hydro metallurgy, geo-sensing, neural networks, reservoir characterization, drilling, geophysics, and more. In addition, ours is the only university level program in the state providing education and research devoted to minerals engineering and the science and engineering of non-renewable resources and sustainability.

Mining has played a pivotal role in the success of the University of Arizona. In fact, the first building constructed at the university in 1888, “Old Main,” was built to house its School of Mines – the first in the state. Since then, we have fulfilled the land grant mission of the University by providing an engineering education focusing on the minerals industries. Our program has furthered technical education for development and extraction of non-renewable natural resources in the State of Arizona, and throughout the world. Those natural resources remain an important part of our state, national, and global economy. Since 1964, the Department has offered degrees in geological engineering with a particular emphasis on geomechanics and rock mass characterization for applications ranging from construction to oil, gas, and mineral development to environmental site characterization. More recently, the creation of the Lowell Mineral Institute in 2009 has proven to be the perfect complement to our existing courses of study, allowing for greater partnership with industry and important advances in the scientific, technological and educational aspects of mineral discovery, extraction and processing, and the concomitant environmental and societal issues.

Today, MGE offers a vast array of opportunities for study, leading to the Master of Engineering (MEng), the Master of Science (MS), and the Doctor of Philosophy (PhD). Four 15-unit graduate certificate programs are available with on-line courses in Rock Mechanics, Mine Health and Safety, Mineral Resources, and Mine Information and Production Technology. The MS is intended for students who want to study in a specialized area and to work closely with a faculty member on a unique research topic and complete an independent research project. The MS degree is the ideal entry point into a PhD program. Students planning to pursue a PhD are strongly encouraged to pursue the MS option. The Master of Engineering degree is structured like an executive MBA program with a combination of coursework, professional projects, and networking with a cohort and industry mentors. The Post-Baccalaureate Certificate Programs, offered in Rock Mechanics, Mine Information and Production Technology, Mine Health and Safety, and Mineral Processing are intended as a continuing education mechanism for working professionals.

Detailed program requirements are described in later sections.

The purpose of this guide is to provide information on the requirements and procedures for pursuing a graduate degree or certificate in the Department of Mining and Geological Engineering at the University of Arizona.

Students are expected to be conversant with the Graduate College requirements and the Graduate Catalog. When in doubt about policies or procedures, you should check with the

Graduate Degree Certification Office (http://grad.arizona.edu). Changes in Graduate College guidelines and requirements supersede those found in this handbook; students should always consult with the Graduate College to ensure they are using current forms, deadlines, and requirements. This handbook is further intended to provide prospective applicants with information to enable them to assess the opportunities for graduate studies in the MGE Department and to assist students in preparing for their programs of study.

It is recognized that the varied backgrounds, objectives, and needs of students may occasionally require interpretation of the guidelines. Under these circumstances, the student's departmental program committee (usually comprising the student's advisor and the faculty members in the student's general area of study) may request a variance from the MGE Graduate Committee (a committee appointed by the department head). The MGE Graduate Committee must approve any changes in writing, and there must be a majority in favor of the changes.

Although this guide adequately describes the department requirements in most situations, there may be special circumstances that lead to uncertainties in the interpretation of the requirements. In this case, the student should consult an advisor. If there is disagreement with any interpretation made by the advisor, the appeal process is as follows: the MGE Graduate Committee can review an advisor's decision and adjudicate the disagreements with a majority rules vote. Finally, the department head can review the committee's decision, or refer the matter to the Graduate College. All decisions by the MGE Graduate Committee should be given in writing.

2. FACULTY AND STAFF ROSTER

The MGE Department is defined by its collaborative, innovative and student centered atmosphere: students, faculty and staff work together as a team, celebrate each other's successes, with a focus on constructive teamwork and cooperation. Our research is inherently multidisciplinary and the depth and breadth of academic disciplines at the University of Arizona plays a pivotal role in the excellence of education and research offered at MGE. Normally your advisor will be a primary faculty member in MGE, but if your research leads you in a particular direction you can work with our joint and adjunct faculty as well. You and your advisors can partner with a variety of units, organizations, and government agencies including (but not limited to): the USGS, NIOSH, Mel and Enid Zuckerman College of Public Health, Eller College of Management, Rogers College of Law, College of Science, Institute for Mineral Resources, Institute for the Study of Planet Earth, Bureau of Applied Research in Anthropology, Udall Center for Public Policy, and so much more, making MGE a perfect fit for interdisciplinary scholarship.

MGE | FACULTY				
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Victor Tenorio	Professor	520-621-3858	Mines 237	vtenorio@ email.arizona.edu
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MGE | STAFF				

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3. WHO TO SEE FOR HELP

A large research university can seem intimidating. You need good information to make good decisions and our faculty and staff are here to help make your graduate experience in MGE a success.

3.1 ACADEMIC ISSUES

In almost every circumstance, you should first pose questions on academic matters to your thesis or dissertation advisor. General questions about the Graduate College policies and procedures for obtaining degrees can also be answered by the MGE office staff. It is usually best to first inquire within the Department, before going to the Graduate College, as this may save you some time and effort. In addition, students must get acquainted with official procedures and deadlines set by the Graduate College. It is the student's responsibility to know and comply with all the requirements set by the Graduate College. Please review carefully the Graduate College Web Site.

3.2 ADMINISTRATIVE ISSUES

CONTACT	AREA OF RESPONSIBILITY
Harshbarger/Mines Business Office	Budgets Payroll Graduate Assistantships Travel Ordering of Supplies
Sherri Raskin	Graduate program in MGE policies and procedures
David Streeter	Rock Mechanics Laboratory Set-Up and Safety Equipment
IT Manager	Computer Hardware and Software http://engr.arizona.edu/help
CCIT: University Computer and Email Accounts (http://computing.arizona.edu/accounts)	

3.3 MGE GRADUATE COMMITTEE

The members of the Graduate Committee are appointed each year by the Department Head. In some cases the Graduate Committee may be a committee of the whole or a subset of the department faculty.

4. ADMISSION

"Quality outcomes are produced by quality students."

You might be surprised to realize that a large number of graduate students in MGE do not have undergraduate degrees in mining or geological engineering. The breadth of the fields we work in accommodate students from a wide range of backgrounds. The background coursework we look for is proficiency in calculus, physics, engineering science (statics and strength of materials), and a basic understanding of geologic principles. Our application acceptance process is competitive and we admit students we believe are dedicated to furthering their education, making a contribution to the profession, and able to meet the high academic standards of the university.

4.1 PROCESS AND REQUIREMENTS

The Application for Graduate Admission, application fee, Test of English as a Foreign Language (TOEFL) scores (as applicable), GRE exam (as applicable), and transcripts for all collegiate work completed with a CUM GPA USA equivalent of 3.0, should be submitted on line to the Graduate College http://grad.arizona.edu/prospect/admissions.php. The MGE Graduate Committee evaluates all of the application materials. The application materials are also routed to specific faculty members with whom the applicant has indicated an interest in working or who have an area of expertise relevant to the applicant's statement of interest. The Committee will normally consider for admission an engineering or science applicant who has attained a B (3.0), or higher, grade average as an undergraduate at an accredited institution and who has a satisfactory GRE score. A student not meeting this GPA requirement, but who has demonstrated a progressive improvement in undergraduate grades, such that the grade average for the last two undergraduate years (approximately the last 60 course units) is B (3.0) or better and who has demonstrated promise through the GRE, may also be considered. While minimum GRE scores are not established for the department, competitive applicants are expected to have scores exceeding the 80 percentile in quantitative and 40 percentile in verbal.

For students who have been out of school an extended period, more emphasis will be placed on the GRE and/or professional accomplishments. Students in the MEng program or in a graduate certificate program do not have to take the GRE if they have a BS degree from a university recognized by the University of Arizona in a math, science, or engineering discipline or a relevant health, or business field and have completed most course pre-requisites in the proposed study program and meet the Graduate College GPA requirements. Ideally, students in a graduate certificate program or the MEng program will have a minimum of two years of professional work experience but this is not a requirement. Students may change from a MS to a MEng under certain circumstances with advisor approval but they must formally apply for the MEng program. Generally, students who have received research support in a MS program will not be allowed to change to a MEng program. Students may change from a MEng to a MS program but must apply for the MS program. Students wishing to change degree program from MS to PhD must first complete the MS degree and then apply for the PhD program through the regular admissions process.

Each of the six emphasis areas in the department has different requirements but in general to undertake graduate work in MGE, incoming students are expected to meet the following minimum requirements for background coursework:

1. Proficiency in mathematics with courses in Calculus as a base, (some graduate focus areas will require knowledge of differential equations).
2. Proficiency in calculus-based physics.
3. Proficiency in engineering science topics covering statics and strength of materials. For some graduate focus areas a course in fluid mechanics is required.
4. Proficiency in chemistry. For some graduate focus areas, more background in chemistry may be required.
5. Geoscience coursework or equivalent experience covering physical geology, basic mineralogy and petrology or an engineering geology course. For some graduate focus areas more background in geology may be required.

Upon admission, each graduate student will receive a written statement of course deficiencies from the Department. The student's advisor may recommend additional background coursework as well. Any request for deviation from the above listed minimum requirements must be justified in writing to the Department Graduate Committee. These deficiencies may be removed by receiving credit for (pass/fail option is acceptable) courses specified by the advisor and Department Graduate Committee or receiving a waiver of the deficiency from the Department Graduate Committee.

If there is disagreement with the list of deficiencies the appeal process is as follows: the MGE Graduate Committee can review an advisor's decision and adjudicate the disagreements with a majority rules vote. Finally, the department head can review the committee's decision, or refer the matter to the Graduate College. All decisions by the MGE Graduate Committee should be given in writing.

Advancement to regular graduate status will not be considered until all deficiencies have been completed.

4.2 GRADUATE STATUS

Students with adequate undergraduate preparation who meet the minimum admission requirements are normally admitted with Regular Graduate Status. Without Regular Graduate Status, a student cannot receive an advanced degree from the MGE Department.

Students holding a Bachelor's degree, or its equivalent, from a college or university, which grants degrees recognized by the University of Arizona may attend graduate-level courses without being admitted to a graduate degree program. Students who are on Non-degree Status (NDS) may enroll in graduate-level course work as their qualifications and performance permit. However, no more than 12 units earned while in this status may later be applied toward an advanced degree awarded by the university. NDS students who later decide to pursue a graduate degree must follow the normal application process through the Graduate College.

4.3 FULL-TIME ENROLLMENT PROVISIONS

4.3.1 FALL AND SPRING SEMESTERS

During the fall and spring semesters, full-time status consists of enrollment for 9 units of graduate credit. Graduate students holding Graduate Assistant/ Associate appointments or working in regular student wage positions must maintain a minimum enrollment of 9 units of graduate credit. A graduate student working on a thesis or dissertation who is

only enrolled in 900-level units and not employed as a Graduate Assistant/ Associate or student worker must be enrolled in 3 units. A student who has completed all course work, the thesis/dissertation unit requirements, has advanced to candidacy, is working on the thesis/dissertation, and is not employed as a Graduate Assistant/ Associate or student worker may apply for advanced status, which allows 1 unit of 900-level credit for full-time status. The full-time status enrollment minimums apply to students wishing to defer federal loan repayments, to international students with F or J visa status, and/or to students receiving University funding other than wages.

4.3.2 SUMMER SESSIONS

During pre-session and first and second summer sessions, full-time status consists of enrollment for 6 graduate units or more in any combination of Pre-Session, First, and Second Summer Sessions. Some colleges (Agriculture & Life Sciences and Engineering) require a greater number of units to maintain full-time graduate status if the student is receiving any financial assistance from the college. A student whose financial aid agreement requires enrollment during the summer sessions should contact the Office of Student Financial Aid to verify specific requirements. International students should check with the University's International Students Office to ensure that their registration is in compliance with their visa status.
http://catalog.arizona.edu/2014-15/policies/fs_enrpol.htm#Full-time

4.3.3 F-1 GRADUATE STUDENTS

- 9 units every Fall and Spring semester; or,
- 9 units every Fall and Spring semester if a student is engaged in paid university assistantships; or,
- 1 or 3 units at the 900 level of thesis or dissertation units every fall and spring semester if a student has completed all course work. Please refer to the Graduate Coursework Completion Form and Graduate College website for full details. This form must be approved and signed by an academic advisor to ISS prior to the first day of semester.
- If degree is to be completed in the summer term, please refer to the Graduate College page on Continuous Enrollment.

http://global.arizona.edu/international-students/maintaining-status

4.4 TRANSFER CREDIT

No more than 6 units of the required 24 course units may be transferred into the department from another accredited institution for the MS, or MEng degrees. A total of 3 units may be transferred into a certificate program. Up to 12 units of graduate credit earned in Non-Degree status and/or transferred from other institutions may be used toward an advanced degree once the student obtains regular admission to a degree program. Students in Non-Degree status must be admitted to a degree seeking program in order to complete a graduate degree. (See http://grad.arizona.edu/admissions/admissions-requirements/non-degree for details). The form for evaluation of transfer credit is available at Transfer Units Form – UAccess Student GradPath and must be completed before the end of the first semester in residence. Such transfer credit, as credit only, will be granted for graduate-level courses in which a grade of A or B (4.0 or 3.0) was earned. Such transfer credit

becomes effective only after completion of 12 units of graduate course work at the University of Arizona, with a minimum grade average of B (3.0). For PhD students, up to 30 units may be transferred from an accredited university subject to approval by the faculty advisor, Graduate Committee, and Graduate College. These units must be in courses relevant to the PhD study program and must meet the requirements for the PhD program.

5. ADVISOR AND PROGRAM COMMITTEE

“You’re not flying solo.”

It takes a team to complete an advanced degree. That team includes your fellow graduate students, perhaps some undergraduate students, faculty from whom you take courses, your major professor or advisor, and your program committee. But you are the reason the team exists. It is up to you to use your team effectively and complete your degree requirements in a timely manner that also meets the standards of the university.

5.1 ADVISOR

Normally, the academic advisor and the "major professor" are the same individual. The student has the freedom to choose his or her advisor, subject to the acceptance of that faculty member and approval by the department head. A student who has accepted research or other support from their major professor and then wishes to change to another major professor must first get approval from the major professor who provided funding. A faculty member who wishes to employ the student of another faculty member should first contact the major professor of that student. It is the student's responsibility to arrange an early appointment with the advisor to review course deficiencies and to organize a tentative study program. In conjunction with the advisor, the student will select a program committee, usually by the end of the first semester. The program committee must meet graduate college requirements for total number of faculty, faculty from the department, and faculty from the university (http://www.grad.arizona.edu). The student and program committee should review the proposed study program (usually by the end of the first semester or at the start of the second semester) and discuss the details of the degree requirements (e.g. paper, project, thesis topic, dissertation topic). All discussions and decisions made with respect to the student’s progress must be documented and a copy must be deposited in the student’s file.

5.2 PROGRAM COMMITTEE

The student should meet to discuss research plans, progress in courses, etc., with the program committee at least once per semester and more frequently with the advisor. It is expected that the student will meet more frequently with his or her advisor as the student progresses further in research. It is the student's responsibility to arrange these regular meetings with the advisor and program committee. The meetings should be documented and a copy of the minutes should be kept in the student’s file. It is in the student's best interests to be made aware of problems with their degree program as soon as possible. Students who do not make satisfactory progress on a research topic, project, or paper will not be allowed to continue solely on the basis of a minimally acceptable GPA. The criteria for acceptable progress for the MS and PhD degrees are listed in Appendix B. Likewise, a student may not continue more than two semesters with a GPA below 3.0, even if the student shows progress in research. It is primarily the advisor’s and program committee’s responsibility to guide the student in course work and research, and to inform the student when he or she is not making satisfactory progress. If the student disagrees with any decision made by the advisor and program committee, he or she can appeal the decision to the Department Graduate Committee, which can overrule the advisor's decision (with a majority vote). Finally, the department head can review the Department Graduate Committee's decision or refer it to the Graduate College.

A new advisor may be chosen by the student if the research topic turns out to be closer to another faculty member's area of specialization. Both the old and the new advisors and the Department Graduate Committee should be informed in writing of the proposed change and agree to the change.

6. MASTER OF SCIENCE PROGRAM

The Master of Science program in the department is designed to increase a student's ability to design and execute challenging professional assignments. The MS program is considered a practicing engineering degree and may require that certain pre-requisites and core courses be completed. The Master of Science degree is the preferred entry point to a PhD program.

A student who plans on completing degree requirements in time for a particular graduation date must submit a "Master's Degree Plan of Study" to the Graduate Degree Certification Office approximately four months before that date. See the Graduate Certification deadlines for exact dates. Forms are available through UAccess Student GradPath. The student will submit the form online through GradPath, where it will be routed for approval by the advisor, and the Department Head. The completed notice contains the student's study program, thesis title, and other information required by the Graduate College. In addition, each student must complete the outcomes assessment form and submit it to the department at the completion of the program. The outcomes assessment document is an internal document for department graduate assessment and does not go to the graduate college.

6.1 PLAN OF STUDY

The department requires a minimum of 24 units of graduate course credit (500 and above level courses) and the completion of a satisfactory thesis for which a maximum of 6 units of credit is awarded. The grade point average for all graduate course work must be 3.0 or above in order to graduate. The grades for course work used to fulfill this requirement must be an A or B. No more than 3 units of graduate work in courses which give P (pass) or S (superior) grades may be submitted for graduate credit, excluding 910 (thesis).

Each student should satisfy the following requirements in completing his or her 30 units for the master's study program: (a) at least 21 units must be in courses for which A or B grades are given, (b) at least 15 units must be in the student's major area as defined by the program committee. The major subject area is that group of courses centered on the thesis, project, or report, which improves the student's background. **The student's advisor and program committee will define the major area**, subject to approval by the Department Graduate Committee. It is recommended that students take at least 9 units of course work in the MGE Department not including thesis or report units. The student may take no more than 6 units of short courses and no more than 3 units of independent studies. A draft of the plan of study should be submitted to the Department Graduate Committee by the registration date for graduate students of the second semester of study.

All work for the master's degree must be completed within a 6 year period to receive credit. This includes transfer course work from other institutions. Unless a waiver is granted by the Graduate College, course work taken more than 10 years before completion, will not be accepted toward the 24-unit requirement for the master's degree. The department will request a time-limit waiver only under exceptional circumstances.

Students in the MS degree program are required to register for and participate in the graduate seminar (MNE or GEN 696A) each semester they are in residence. One unit of seminar credit is applied toward the program of study. The seminar series is designed to build camaraderie, promote professional communication, provide experience in critiquing and giving a professional presentation, and develop networking skills.

Students in the MS degree program are required to give one public technical talk either at a conference or the department seminar.

The department requires 3 units of graded credit in computer-intensive, mathematics-intensive, and/or statistics-intensive courses. These courses include geostatistics, and courses in SIE, signal and image processing in ECE, and inverse theory in GEOS. These courses must be identified in the planned course of study and approved by the advisor and Department Graduate Committee.

The Master of Science consists of the following requirements:

Required courses 0-6 units of short courses 0-3 units of independent studies 1 unit of research seminar	24 units
Thesis	6 units
TOTAL:	**30 units**

6.2 THESIS

The department requires students in the Master of Science to write, and defend, a thesis. The department makes this requirement because designing a research program, carrying it out, and presenting the results are essential parts of a professional engineer's duties. The student may wish to examine theses written by former students, which are in the department library, in order to obtain a better idea of the scope and format of a thesis or report.

The requirement for a Master's thesis in this department is an original contribution to the field, which can include but is not limited to collection of data, analysis of existing data sets, creation of computer programs, or development of new procedures, policies, or methodologies. Ideally, the thesis should result in one peer-reviewed journal publication. Graduate students are advised to read “A Manual for Theses and Dissertations”, which is available at https://grad.arizona.edu/gcforms/sites/gcforms/files/page/thesisformattingguidenov2013revision.pdf.

Theses and reports must be edited for style, grammar, and logical organization prior to being submitted to the advisor and program committee. It is the student’s responsibility to ensure that the draft submitted to the advisor is in well-written, standard English. Writing advice is available through various sources on campus and also from professional editors which are hired at the student’s expense.

The normal sequence of events for submitting a thesis is:

1. Submit a professional written and edited draft to the advisor
2. Once the advisor has reviewed the draft, the student must make all required revisions
3. The revised draft is sent to the program committee for review
4. The program committee reviews the draft and requests revisions

5. The draft can be approved for defense by the program committee or the program committee can require review of another draft prior to the defense
6. Once the program committee and advisor have approved the draft, a defense is scheduled.

An electronic version of the thesis or report should be submitted to the department. The electronic version (in .pdf format) may be posted on the department website at the discretion of the advisor and program committee. If the full thesis or report is not published on the website, at a minimum the student's name, title of thesis/report and abstract may be published. Publication of the thesis or report is strongly encouraged and the student should make a commitment to conduct scholarly work at a level that is satisfactory for publication in a journal or scientific conference.

6.3 FINAL EXAMINATION

Each candidate for a master's degree in the department must pass an oral final examination. The examination will cover the thesis or report and will also include questions to test the student's competence in the subjects presented in his or her study program. The student should plan on an examination of approximately two hours. The student will make a presentation of the thesis or report. In addition to the examining committee of at least three faculty members, other members of the University staff, interested professionals from outside the University and students may be invited to sit in on the thesis defense, as nonvoting participants. The timing of the final examination is critical only if the student wishes to participate in a particular graduation ceremony. The final examination should be scheduled approximately one month before the intended graduation date. Students will schedule the final examination with the Front Office to reserve a room. See the Graduate Degree Certification Deadlines for the exact dates. The student is required to fill out a form entitled "Master's/Specialist Completion of Degree Requirements" before appearing for his or her examination. This form allows the student to make minor changes in the thesis title or course offerings subject to approval by the student's advisor. When scheduling the final examination, the student should also allow enough time to make agreed changes in the thesis in order to submit the approved thesis to the Department approximately fifteen days prior to graduation. See the Graduate Degree Certification Deadlines for the exact dates. After making any required corrections, three unbound copies of the approved thesis and the abstract must be submitted to the Department to meet the approximately 15-day graduation deadline.

Any student who fails the final examination may, upon recommendation of the major department and approval of the University Graduate Council, be granted a second examination after a lapse of at least one semester. A representative of the Graduate Council must be present at the second final examination. The examining committee should be the same as those who were present at the first examination attempt, unless a waiver is granted by the Department Head.

6.4 RECORD-KEEPING

The candidate is responsible to schedule a meeting with the program committee at least once a semester to review progress. The candidate must take minutes at the meeting and submit an approved copy to the department on official form (see department office). The minutes must accurately state the issues discussed at the meeting and the program committee's recommendations and comments.

7. MASTER OF ENGINEERING PROGRAM

The Master of Engineering (ME) program is primarily intended for working professionals, and while it is not a terminal degree, students considering entering a PhD program in the future should choose the MS program. The program requires an undergraduate degree in an engineering discipline or a related science, health, or business discipline. Prerequisites in calculus, physics, and chemistry must be satisfied prior to applying to the program. Prerequisites in engineering science and geology should be taken prior to applying, and in some circumstances students will be allowed to take a few remaining prerequisites in their first semester Students with a BS degree in an engineering, math, or science discipline, qualified business or health disciplines, and a cumulative GPA of 3.0 at the undergraduate level do not have to take the GRE to enter the ME program. Graduates of non-US institutions will have to meet the university requirements for admission (http://grad.arizona.edu/admissions). The ME program does not have a residency requirement and most courses will be offered on-line so a student in a foreign country may not be required to obtain a US entry visa. International students interested in the ME program should consult the proper authorities regarding visa requirements. It should be noted that courses taken outside the Mining and Geological Engineering department may not be offered online.

The ME program is designed to be flexible and to accommodate practicing engineers who are taking courses primarily from web at the UA. Students in the ME program will form a program committee similar to a MS program committee and must submit a program of study to the program committee for approval. Students are required to give a capstone seminar. A minimum of 15 units of graded coursework must be from the College of Engineering. A maximum of 6 units can be transferred from another university. Students in the program are not restricted from receiving funding to support their report work.

The ME program consists of the following requirements:

Core courses: • At least 9 units in emphasis area • 5-8 units of electives (including up to 6 units of one-unit short courses) • 0-3 units of independent study or report	17 units
Business / Engineering Management (at least)	3 units
Applied Engineering/Mathematics (at least)	3 units
Entrepreneurship/Innovation/Design (at least)	3 units
Advanced Engineering Science (at least)	3 units
Research Seminar	1 unit
TOTAL:	**30 units**

Students must select one emphasis area and take at least 9CH from that area and 5-8CH of elective courses from one or more of the areas listed below. Additionally, all ME candidates must enroll in one unit of MNE 696A. Students in the ME program may take no more than 6 units of short courses and no more than 3 units of independent studies or report. Some examples of emphasis areas are given below. However, additional emphasis areas are possible

within the general topics of mining engineering, geological engineering, geophysical engineering, and other appropriate areas for our department.

Example Emphasis Areas (at least 9CH not including short courses)

- Mine Information and Production Technology MNE 507 Equipment Operations Technology (web), MNE 509 Management Operations Technology (web); MNE 696B Modern Mining Operations Systems; MNE 587 Applied Neural Network Computing (web); MNE 519 Mine Planning Software (short course); MNE 534 Surface Mine Design (web); MNE 538 Underground Mine Design (web); SIE 554A The Systems Engineering Process (web); SIE 531 Simulation Modeling and Analysis (web); SIE 548 Operations Research Modeling (web);

- Mine Health and Safety MNE 526 Health and Safety in Mining (web), MNE 521 Disease and Illness in Mining (web); MNE 576 Fundamentals of Mine Ventilation; CPH 553 Toxicology and Chemical Exposures (web); CPH 522 Safety Fundamentals (web); CPH 576a Biostatistics (web) (may be used to satisfy math requirement); CPH 577 Social and Behavioral Aspects of Public Health (web); CPH 574 Health Administration and Policy (web); CPH 575 Environmental and Occupational Health (web); CPH 573a Basic Principles of Epidemiology (web)

- Geomechanics MNE 527 Geomechanics (web); MNE 547 Underground Construction Geomechanics (web); MNE 580 The Mechanics of Failure in Rock and Other Brittle Materials (web); MNE 515 Rock Excavation (web); CE 540 Soils Foundation Engineering; CE 541 Earth Structures

- Mineral Processing MNE 511 Mineral Processing (web); MNE 539 Surface Chemistry of Flotation (web), MNE 550 Elements of In-situ Leaching (web), MNE 565 Hydrometallurgy (web), MNE 567 Applied Pyrometallurgy (web)

- Sustainable Resource Development MNE 522 Engineering Sustainable Development (web); MNE 541 Environmental Management and Mine Reclamation (web); ABE 526 Soil and Water Conservation Engineering; AREC 576 Natural Resource Law and Economics

- Mine Management MNE 530 Mine Examination and Valuation; MNE 696C Introduction to Engineering Contract Law (short course); MNE 696x Leadership for Engineers and Scientists (short course); MNE 696x (short courses) Mineral Economics Concepts, Mine Finance, Introduction to Financial Institutions, Modern Corporate Organizations in the Minerals Industry, International Minerals Trade, Innovation Process; Short courses in economic geology as offered by UA Geosciences; Important note for this emphasis area: see comment about short courses below.

Electives (5-8CH) Students must complete 5-8CH of elective coursework. These courses are subject to the approval of the advisory committee. Up to 6 units of short courses (696x, 697x, etc.) may be used as elective credit.

Business Fundamentals (at least 3CH)
Take one of the following courses: SIE 557, ENGR 565, MNE 530

Applied Engineering/Mathematics (at least 3CH)
Take one of the following courses: SIE 530, ABE 513, MNE 502

Entrepreneurship/Innovation/Design (at least 3CH)
Take one of the following courses: SIE 567, MNE 534, MNE 515

Advanced Engineering Science (at least 3CH)
Take one of the following courses: MNE 527, MNE 511, MNE 507

Independent Study (MNE 599) or Report (MNE 909) (up to 3CH) Students may take up to 3 units of project or independent study. The project or independent study must be appropriate to the student's plan of study, and is subject to the approval, in advance, by the student's advisory committee.

RECORD-KEEPING

The candidate is responsible to schedule a meeting with the program committee at least once a semester to review progress. The candidate must take minutes at the meeting and submit an approved copy to the department on official form (see department office). The minutes must accurately state the issues discussed at the meeting and the program committee's recommendations and comments.

8. CERTIFICATE PROGRAMS

The Post-Baccalaureate Graduate Certificate program consists of 15 units of focused course work in: Rock Mechanics; Mine Health and Safety; Mineral Processing; and Mine Information and Production Technology. Students wishing to complete a certificate will be assigned a faculty advisor who is involved in administering the courses for an established certificate program. Minimum admissions requirements and minimum pre-requisites for the certificate program are similar to the Master of Engineering. Students with an MS or PhD may also enter the certificate program provided the certificate program is not part of their prior study areas. All certificate programs can be completed as either online or on campus programs.

9. DOCTORAL PROGRAM

The doctoral program is designed to prepare a professional engineer for senior responsibility in industry, research, or teaching. The successful candidate must demonstrate the ability to devise and execute a program of study and research, which makes a fundamentally new contribution to the chosen field. The most important aspect of the doctoral program is the dissertation, which is the evidence of this fundamental contribution. The student should be prepared for an often lengthy and certainly very demanding period of study beyond the master's degree. The PhD dissertation must disclose:

1. The development of new techniques, principles, or theories;
2. The use of old established techniques, principles, or theories in a new and/or unique manner; and/or
3. The use of new information and the discovery of new findings if it is described in terms of an original model or process.
4. It should also lead to at least two significant papers published in a reviewed journal at the discretion of the advisor and program committee.

A collection of facts and information, no matter how carefully organized or described, does not by itself constitute a PhD dissertation. A PhD research program will often make use of the contributions from a faculty advisor and others, but it should be clear exactly what creative contribution the PhD candidate has made to the research.

The students in the doctoral program should meet to discuss research plans, progress in courses, etc., with the program committee at least once per semester and more frequently with the advisor. It is expected that the student will meet more frequently with his or her advisor as further progress is made in the research project. It is the student's responsibility to arrange these regular meetings with the advisor and program committee. The meetings should be documented and a copy of the minutes should be kept in the student's file. It is in the student's best interests to be made aware of problems with their degree program as soon as possible. Students who do not make satisfactory progress on a research topic, project, or paper will not be allowed to continue solely on the basis of a minimally acceptable GPA

9.1 RESIDENCE AND COURSE REQUIREMENTS

The minimum time to complete a doctoral program is six semesters, two of which must be as a full-time resident in the department. To be considered as a semester of full-time residency, a student must register for and complete at least 9 units of graduate course work or research.

Students who are on a research or teaching assistantship must register for 9 units each semester. These 9 units may be any combination of courses, independent study, thesis, or supplemental registration.

All requirements for the degree should be completed within five years of passing the comprehensive exam. At least 12 of the minimum 66 units of graduate credit required must be completed at the University of Arizona with a grade of A or B. Students must complete 18 units of dissertation credit. A minimum of 36 units of graduate level courses, exclusive of dissertation or thesis units, must be in the major subject area. The major subject area is

that group of courses centered on the dissertation, which improves the student's background for eventual preparation of the dissertation, as defined by **the student's advisor and program committee**, subject to approval by the Department Graduate Committee. Course and thesis work completed as part of an accredited master's program may be counted as part of the 66 unit minimum, if they fall within the major subject area. No more than 6 units of credit toward the dissertation units will be granted for the master's thesis if the thesis was submitted to the University of Arizona. Master's theses from other institutions are accepted only with the approval of the student's program committee and the Department Graduate Committee. One or two minor subject areas, typically comprising a total of at least 12 units of course work as specified by the minor department(s), are required. The minor subject area is selected to provide additional background information pertinent to the preparation of the dissertation.

The department requires 6 units of graded credit in computer-intensive, mathematics-intensive, and/or statistics-intensive courses. These courses include geostatistics, courses in SIE, signal and image processing in ECE, and inverse theory in GEOS. These courses must be identified in the planned course of study and approved by the candidate's program committee and Department Graduate Committee.

MINIMUM COURSE REQUIREMENTS	**NORMALLY MET BY:**
36 units	24 units (from master's degree in major area) 12 units (major area): 6 units of intensive Math/Computer/Stats 0-6 units of short courses 0-6 units of independent study 2 units of research seminar
12 units (minor area/s)	12 units (minor area)
18 units (dissertation)	18 units (dissertation)
66 units TOTAL	**66 units TOTAL**

The doctoral student will commonly complete more than the 66-unit minimum requirement. The student will find it very difficult to satisfy the need to know and understand the subject within the minimal requirements. The student's advisor may also specify additional course requirements as necessary to insure the student' understanding of the relevant subject matter. Not all of the additional courses need to be included on the formal doctoral study program. Furthermore, the student must maintain a B (3.0) or better overall average in graduate courses, with a minimum B (3.0) average in the major area. Failure to maintain the required grade average is grounds for probation and eventual dismissal, at the discretion of the student's program committee.

Students in the doctoral program may take no more than 6 units of short courses and no more than 6 units of independent studies. Students in the PhD degree program are required to register for and participate in the graduate seminar (MNE or GEN 696A) each semester until such time as the oral comprehensive examination is completed. Two units

of seminar credit are applied toward the program of study. The seminar series is designed to build camaraderie, promote professional communication, provide experience in critiquing and giving a professional presentation, and develop networking skills.

Students are required to give two public technical talks or department seminar presentations prior to the defense of their dissertation.

9.2 STUDY PROGRAM

A formal program of study together with an outline of the proposed dissertation should be formulated between the second and the third semester in residence. This coursework should be listed on the "Doctoral Plan of Study" form, which is available through UAccess Student GradPath. At this stage, the student should have picked his or her major advisor and the minor advisor and program committee. If the student's advisors, program committee and the MGE Graduate Committee approve the program, it is then submitted to the Graduate Degree Certification Office for consideration.

9.3 FOREIGN LANGUAGE REQUIREMENT

The department does not have a foreign language requirement. However, because of the increasingly international nature of the field, the department recommends that students give serious consideration to developing communication skills in a foreign language other than their native tongue or English.

Instead of the foreign language requirement, the department requires 6 units of graded credit in computer-intensive, mathematics-intensive, and/or statistics-intensive courses outside the department. These courses must be identified in the plan of study and approved by the program committee, and Department Graduate Committee.

9.4 THE COMPREHENSIVE EXAMINATION

After completing the study-program course work, the doctoral student must schedule a comprehensive examination in both the major and minor fields, usually at the end of the second year of graduate work. The initial part of the examination is written. An oral examination follows a successful written examination. The form entitled "Application for Oral Comprehensive Examination for Doctoral Candidacy" should be submitted to the Graduate Degree Certification Office at least 3 weeks before the date of the oral exam. The comprehensive examination committee is normally composed of three faculty members selected from the faculty of the major area and one faculty member from the student's minor field. A specially qualified professional from outside the University may serve as a full member of this committee.

The written part of the examination prepared by the department may be either an open-book or a closed-book test, depending upon the preference of the individual faculty. The committee members from other departments will apply their own procedures. The purpose of the test is to assess how the doctoral student reasons while determining the breadth of knowledge in the student's chosen field.

The oral examination may cover any topic listed in the study program, or basic to that program. This examination is intended to test the student's comprehensive knowledge of

the major and minor subjects of study, both in breadth across the general field of study, and in depth within the area of specialization. Normally, the Oral Exam will also include a discussion of the student's proposed dissertation topic. The student should be prepared to present a brief summary of the dissertation proposal during the oral exam. The written and the oral must be taken within a 6-month period. If more than 6 months pass before the oral, the student must submit a petition to take the oral exam. The program committee must recommend or reject "Advancement to Candidacy" after the comprehensive examination is complete. The doctoral candidate may schedule the “final examination and dissertation defense” for any time three months after his or her “Advancement to Candidacy". If the student fails the comprehensive examination, one re-examination is possible on the recommendation of the committee and with the approval of the Department Graduate Committee and the department head. Only one re-examination is granted. If it is granted, at least on full semester waiting time from the first examination date is needed for the second examination date. Committee actions need not be unanimous; two negative votes will reject a student. The oral exam is closed to the public.

9.5 DISSERTATION AND DEFENSE

Usually the work on the PhD dissertation will require full-time effort from the candidate during the final year or two. For guidelines on the preparation of the dissertation, see "A Manual for Theses and Dissertations", which is available at https://grad.arizona.edu/gcforms/sites/gcforms/files/page/thesisformattingguidenov2013revision.pdf.
Three weeks prior to the date of the final examination, the candidate must submit the form entitled "Announcement of Final Oral Examination” to the Graduate Degree Certification Office. The student must arrange an acceptable date and time for the program committee to make its final examination and hear the student’s defense of the dissertation. All three of the major study area members of the program committee must be present at the final examination. Attendance by the committee members from the minor field is not required, but they must be invited and are entitled to vote, if present. Again, two negative votes will fail the candidate. The final examination, the time and place of which is to be announced at least one week in advance, is open to the public. All interested faculty and students may attend the final examination, which represents the culmination of considerable effort on the part of the candidate.

9.6 DISSERTATION IN ABSENTIA

Under certain circumstances, the student may prepare part of the dissertation in absentia. Permission must be granted through formal petition for in-absentia work before such work commences. Before in-absentia work can be approved, the dissertation must be well defined, the literature search and background study well developed, and a suitable plan for liaison prepared. Adequate supervision of the student's work must be maintained, and, on field-oriented problems, provision must be made to have the faculty advisor, or representative, visit the area to review the problem and the student's work. To request in-absentia status, the student must complete a petition form, outlining why such status is requested and demonstrating that the guidelines for in-absentia status have been met. The request will be reviewed by the Department Graduate Committee, who may recommend for approval, for denial, or for conditional approval. In the last instance, examples of additional conditions which may be required are completion of analytical work in residence, preparation of a rough draft in residence, or return to residence status for the semester preceding graduation. Any student using University of Arizona facilities or services (e.g. library, faculty

advisor, dissertation defense, etc.) must be registered. The student must maintain continuous registration status each semester until all degree requirements are met.

9.7 DEPOSIT OF MATERIALS IN DEPARTMENT ARCHIVES

The student must carefully organize and file in the department all supporting material for the dissertation. This may include rock samples, maps, data, computer programs, copies of personal communications that are referenced in the dissertation, etc. As with any rigorous scientific work, it must be possible to duplicate the student's experiment, verify the data, computer programs, or theoretical developments. In general, the use of proprietary data, computer codes, or techniques which cannot be placed in the public domain for scientific scrutiny are incompatible with the goals of the dissertation. Exceptions can be made, when necessary, by the Department Graduate Committee. An electronic version of the dissertation in .pdf format must be submitted to the department and may be posted on the department website at the discretion of the advisor. If the full dissertation is not posted to the website, at a minimum, the student’s name, dissertation title, and abstract will be posted.

9.8 RECORD-KEEPING

The candidate is responsible to schedule a meeting with the program committee at least once a semester to review progress. The candidate must take minutes at the meeting and submit an approved copy to the department on official form (see department office). The minutes must accurately state the issues discussed at the meeting and the program committee’s recommendations and comments.

10. GRADUATE COLLEGE FORMS, GUIDELINES, AND LINKS

We recommend using the Graduate College website so that you will have the most up-to-date guidelines, forms and policies. Almost all of the Graduate College forms you will fill out are found through your UAccess Student GradPath.

- Graduate College – www.grad.arizona.edu
- Deadlines - http://registrar.arizona.edu/schedules/dates.htm
- Financial Support - http://grad.arizona.edu/financial-resources
- Online Application for Admission - http://www.grad.arizona.edu/admissions/apply-now
- Theses & Dissertations Manual – PDF document is available here

11. TIMETABLE FOR GRADUATE DEGREE COMPLETION

11.1 MASTER'S LEVEL

1. First semester of residence: meet with advisor, form program committee, draft plan of study, verify plan for completion of deficiencies.
2. Second semester of residence: submit plan of study to Department Graduate Committee for approval, outline thesis or report topic and distribute to advisor and program committee, submit plan of study and thesis title to Graduate College, continue coursework/research, meet with program committee to review progress.
3. Third semester (as needed): continue with coursework/research; meet with program committee to review progress upon advisor recommendation.
4. Fourth semester through end of program (as needed): continue with coursework/research; meet with program committee to review progress. Have thesis or report reviewed by outside editor for proper English before submitting to advisor for review, submit to program committee for review, schedule defense after draft thesis or report has been reviewed and approved by program committee

11.2 PhD LEVEL

1. First semester of residence: meet with advisor, form program committee, draft plan of study
2. Second semester of residence: continue coursework/research, meet with program committee to review progress, prepare the qualifying examination (or apply for waiver from Department Graduate Committee with advisor approval).
3. Third semester of residence: continue with coursework/research, meet with program committee to review progress, finalize plan of study and submit to Department Graduate Committee.
4. Fourth semester of residence: continue with coursework/research, meet with program committee to review progress, meet with advisor to discuss scheduling of comprehensive exams.
5. Fifth semester: schedule comprehensive exams, meet with program committee at discretion of advisor, and keep program committee updated on progress.
6. Sixth semester until completion: complete research, meet regularly with advisor and keep program committee updated on progress, have dissertation reviewed by outside editor for proper English before submitting to advisor for review, submit to program committee for review, schedule defense after draft dissertation has been reviewed and approved by program committee.

APPENDIX A: BENEFITS FOR GRADUATE STUDENTS

GRADUATE ASSISTANTSHIP GUIDELINES

REQUIREMENTS:

- Be a student and enrolled in a graduate degree program at the University of Arizona.
- Have an admitting GPA of 3.0 or higher if a new student or maintain a 3.0 cumulative GPA for all University of Arizona graduate credit courses.
- Graduate Associates must in addition to the above be enrolled in a doctoral degree program with either a master's degree or 30 units of doctoral work at the UA.
- Retain associate status unless converted to a non-doctoral degree program as a Graduate Assistant or change hiring departments.

EMPLOYMENT STATUS AND LIMITATIONS:

- Limited to no more than 30 hours per week in total campus employment during periods of enrollment to maintain student employee status. Employment for International Students on F-1 or J-1 visas must be limited to 20 hours per week while school is in session. **This is a federal regulation.**

- Exempt from deductions for Social Security taxes during semesters or summer session when officially enrolled. **Minimum enrollment for the exemption is six units per semester for Fall/Spring or three units per summer session.**

ENROLLMENT LIMITATIONS - ACADEMIC YEAR: FALL & SPRING SEMESTER

Minimum enrollment: GAs are required to enroll for a minimum of nine (9) units of graduate credit each semester. Undergraduate and/or officially audited graduate courses are NOT included in this total.

Minimum Training Requirements:

- **TATO:** Teaching Assistant/Associate Training Online (TATO) is a collection of self-paced modules about teaching and learning made available via D2L. All students who are appointed as Teaching Assistants/Associates (TAs) must complete the module "*Staying Out of Trouble: UA Policies"* and pass the test with a score of 95% or higher no later than two weeks after the start of classes. It is recommended that TAs review the information from all modules in TATO before the beginning of each semester. Individual departments may also assign *additional* modules from TATO. Additional information: https://grad.arizona.edu/funding/ga/mandatory-online-training

- **TOEFL:** All GA's whose native language is not English and who do not have a degree from a U.S. institution must have a minimum score of 550 (paper-based test) or 213 (computer-based test) on the Test of English as a Foreign Language before their appointment as a GA. The Speaking Section must have a minimum score of 24

BENEFITS FOR GRADUATE ASSISTANTS/ASSOCIATES

- **Tuition Remission:** Eligible for partial payment of their standard in-state tuition. Remission amount is dependent on FTE. GA's appointed at half time or greater will receive a 60% remission and those appointed at less than half-time receive a 49.1% remission. This benefit is not available for summer sessions.

- **Nonresident Tuition Waiver:** All GA's who are not residents of the State of Arizona receive a nonresident tuition waiver.

- **ASUA Bookstore Discount:** 10% discount at all ASUA Bookstores, with a valid CAT card.

- **Payroll Deduction Plan:** Can elect to have their remaining portion of their in-state tuition (registration fees) deducted directly from paychecks.

- **Student Health Insurance:** Individual health insurance coverage will be paid by the U of A. To be eligible for this benefit you must have signed the Notice of Appointment, be registered, and have ordered the insurance coverage through Student Link.

GRADUATE COLLEGE FELLOWSHIPS

Beginning with the academic year 2012-13 **ALL** graduate students who are awarded Graduate College Fellowships from the academic units **MUST show a level of need before receiving the funds**. The new guideline is in addition to the ongoing requirements of degree seeking, enrolled in 3 units or more, in good academic standing, and a 3.0 or higher GPA. Need is calculated on the previous year's income which may change from year to year.

To demonstrate a level of need:

- Domestic Students must file the Free Application for Federal Student Aid (FAFSA) BEFORE any funds will be disbursed. You may locate the FAFSA information through UAccess Student under Student Center Services, under the financial aid tab at the far right (as shown on page 2 of this announcement).

- International Students must submit the Financial Aid Calculation for International Students in Masters / Doctoral Programs to the academic unit's graduate coordinator who will forward it to the Office of Student Financial Aid (OSFA) for review at OSFA-DeptAskAid@email.arizona.edu. This is BEFORE any funds will be disbursed. This is the ONLY document source to show need and will be electronically housed within OSFA and not on UAccess. Please note that it is the last page of this document that must be filed.

Please be sure that you read your Notice of Appointment completely. There are requirements that need to be met. If a student resigns or terminates prior to the end of the assistantship he/she will be held responsible for payments of tuition and a premium for the remaining insurance coverage.

APPENDIX B: SATISFACTORY PROGRESS GUIDELINES

Per March 3, 2004 Graduate College memo, “In addition to meeting Graduate College Rules for Satisfactory Academic Progress, students must also adhere to [the MGE guidelines] for satisfactory academic progress.”

“When a student fails to meet program guidelines for satisfactory progress, the student must receive written notification with a clear statement of what the student must do and a date by which such actions must be completed. The Graduate College should receive copy of letters of unsatisfactory progress. Students must be given an opportunity to appeal or rebut, and program guidelines must indicate a process for appeals. Students who fail to remediate by the deadlines specified may be dismissed from the program. Students have the right to appeal such decisions to the Graduate College, but the Graduate College will limit its review to whether or not the program followed their established policies.”

The following timetables represent the minimum progress a MGE graduate student must maintain to avoid being disqualified. Full-time students in serious pursuit of a graduate degree should use a timetable of two years to complete a thesis-option MS degree and three more years to complete a PhD.

MS Degree	Year 1	Full-time student	• Complete any existing deficiencies or complete at least 12 units of graded non-seminar courses for program of study. • Identify thesis topic and committee.
		Part-time student	• Complete at least 6 units of graded non-seminar courses for program of study
	Year 2	Full-time student	• Complete remaining coursework • Pursue thesis or report research • File for degree
	Year 2	Part-time student	• Complete at least 6 units of graded non-seminar courses for program of study • Identify thesis topic and committee
	Optional Year 3	Full-time student	• Finish thesis or report research and defend
	Year 3	Part-time student	• Complete remaining coursework • Pursue thesis or report research • File for degree
	Optional Year 4	Part-time student	• Finish thesis or report research and defend

PhD Degree	Year 1	Complete existing deficiencies or complete at least 12 units of graded non-seminar courses for program of study Identify research area, advisor, and program committee Identify minor Pass qualifying exam by end of third semester
	Year 2	Complete existing deficiencies or complete at least 12 graded non-seminar courses for program of study Meet at least once a semester with the program committee (submit minutes of the meeting to the department) Prepare for the comprehensive exam
	Year 3	Complete remaining coursework Pass written and oral comprehensive exams File for application to candidacy Pursue doctoral research Meet at least once a semester with the program committee (submit minutes of the meeting to the department)
	Year 4	Complete research and write dissertation Meet at least once a semester with the program committee (submit minutes of the meeting to the department) Prepare for the final exam Pass final exam Submit final copy of dissertation

APPENDIX C: LAB SAFETY MANUAL

Geomechanics Laboratory D.W. Streeter
Dept. of Mining and Geological Engineering
The University of Arizona

These rules are for the safety and protection of people and equipment in the lab areas. Please read and follow them.

1. Wear proper foot protection in the lab areas. Steel-toed shoes are best, but good street shoes are acceptable. Students wearing open-toed shoes WILL NOT be allowed to work in any of the labs.

2. Wear safety glasses or goggles when grinding, cutting, or drilling.

3. Wear safety gloves and use hand truck when lifting and handling heavy, cumbersome, or sharp-edged pieces of rock, steel, etc.

4. Smoking is not permitted anywhere in the building.

5. Know how to use the equipment **BEFORE** you use it. If you have any questions, please ask the Lab technician who can instruct you on how to operate the equipment.

6. Rooms 119, 29 and 31 are generally open M-F, 8:00 to 5:00. You may work at night, or weekends, **with permission,** only if you work with a partner. Please plan your testing accordingly.

7. Please keep the lab areas and equipment clean. The custodians only remove trash and may occasionally sweep the floor. Most cleaning, especially of equipment, must be done by personnel actually doing the preparation and testing of samples. Cleaning up will be greatly appreciated.

8. Always work in a group of at least two people, and under no circumstances run any of the equipment when you are alone in the room.

9. All personnel must read and sign: "**MGE GEOMECHANICS LABORATORY USAGE POLICY AND THE 2015 LABORATORY SYLLABUS"** before they will be allowed to operate any lab equipment.

BASIC SHOP RULES - issued by University of Arizona Risk Management Services are posted in all work areas.

APPENDIX D: SUGGESTED PHD MATH AND COMPUTER COURSES

Friday, September 05, 2014
11:51 AM

MATH 509C Statistics for Research
Statistical concepts and methods applied to research in other scientific disciplines. Principles of estimation and hypothesis testing for standard one-and two-sample procedures. Correlation, linear regression. Contingency tables and analysis of variance.

MATH 522 Advanced Applied Mathematics
Applications of vector calculus, complex variables, and Sturm Liouville theory. Fourier series, Fourier and Laplace transforms, and separation of variables in classical partial differential equations. This course takes a more mathematical approach than Math 322. Graduate-level requirements include more extensive problem sets or advanced projects.

ANYTHING IN STATISTICS PROGRAM
STAT 571B Design of Experiments
Principles of designing experiments. Randomization, block designs, factorial experiments, response surface designs, repeated measures, analysis of contrasts, multiple comparisons, analysis of variance and covariance, variance components analysis.

GEOG 517 Geographic Information Systems for Natural and Social Sciences
Introduction to the application of GIS and related technologies for both the natural and social sciences. Conceptual issues in GIS database design and development, analysis, and display. Graduate-level requirements include a thorough bibliographic review and a scholarly paper on a current application of geographic information systems in the student's major field.

GEOG 519 Cartographic Modeling for Natural Resources
Computer techniques for analyzing, modeling, and displaying geographic information. Development of spatially oriented problem design and the use of logic are applied to the use of GIS programs. Emphasis on applications in land resources management and planning. Graduate-level requirements include a research paper.

GEOG 520 Advanced Geographic Information Systems
Examines various areas of advanced GIS applications such as dynamic segmentation, surface modeling, spatial statistics, and network modeling. The use of high performance workstations will be emphasized.

GEOG 574G
[Taught Spring semester in odd-numbered years] Exploratory spatial data analysis, random function models for spatial data, estimation and modeling of variograms and covariances, ordinary and universal kriging estimators and equations, regularization of variograms, estimation of spatial averages, non-linear estimators, includes use of geostatistical software. Application of hydrology, soil science, ecology, geography and related fields.

SIE 500A Introduction to SIE Methods: Probability and Statistics (not currently offered)
Axioms of probability, discrete and continuous distributions, sampling distributions. Applications of statistical estimation, hypothesis testing, confidence intervals.

SIE 500B Introduction to SIE Methods: Stochastic Methods (not currently offered)
Introduction to probabilistic models commonly used in systems and industrial engineering and related disciplines. Markov chains, Poisson processes, queuing models

SIE 500C Introduction to SIE Methods: Linear Programming (not currently offered)
Linear programming models, solution techniques, and duality.

SIE 520 Stochastic Modeling I
Modeling of stochastic processes from an applied viewpoint. Markov chains in discrete and continuous time, renewal theory, applications to engineering processes

SIE 522 Engineering Decision Making Under Uncertainty
Application of principles of probability and statistics to the design and control of engineering systems in a random or uncertain environment. Emphasis is placed on Bayesian decision analysis. Graduate-level requirements include a semester research project.

SIE 525 Queuing Theory
Application of the theory of stochastic processes to queuing phenomena; introduction to semi-Markov processes; steady-state analysis of birth-death, Markovian, and general single- and multiple-channel queuing systems.

SIE 530 Engineering Statistics
Statistical methodology of estimation, testing hypotheses, goodness-of-fit, nonparametric methods and decision theory as it relates to engineering practice. Significant emphasis on the underlying statistical modeling and assumptions. Graduate-level requirements include additionally more difficult homework assignments.

SIE 531 Simulation and Modeling Theory
Discrete event simulation, model development, statistical design and analysis of simulation experiments, variance reduction, random variate generation, Monte Carlo simulation. Graduate-level requirements include a library research report.

SIE 533 and higher except 557 Project Management, 596E Ethics for Engineers

CE 548 Numerical Methods in Geotechnical Engineering
Brief statements and applications of numerical methods based on closed-form solutions, finite difference and finite element methods for problems involving soil structure interaction such as piles, retaining walls, group piles, underground works; seepage; and consolidation. Graduate-level requirements include additional assignments, e.g. a research paper on specific topics.

HWR 645, 655 Stochastic Modeling in Subsurface and Surface Hydrology

MIS 507 Software Design and Integration
The course will begin with a discussion of techniques and notations for object-oriented modeling. Building on these modeling techniques, we will then discuss strategies for implementing reusable and extensible systems and in particular design patterns--templates for software design that have been proved to deliver great practical value. The course will also cover a selected set of software engineering and project management issues and the current thinking on what constitutes the best practice to deal with these issues.

MIS 541 Information Systems Analysis and Design
This course provides an understanding and application of system analysis and design processes centered on the systems development life cycle. Core topics include: project management and cost-benefit analysis; information systems planning and project identification and selection; requirements collection and structuring; process modeling; conceptual and logical data modeling; database design and implementation; design of the human-computer interface (HCI); system implementation; system maintenance and change management. Students will also be introduced to comparative development methodologies and modeling tools. The course involves a substantial group project where students will learn the importance of effective communication and integration with users and user systems. The course emphasizes interpersonal skill development with clients, users, team members, and others associated with development, operation, and maintenance of systems.

MIS 545 Data Mining for Business Intelligence
Corporations today are said to be data rich but information poor. For example, retailers can easily process and capture millions of transactions every day. In addition, the widespread proliferation of economic activity on the Internet leaves behind a rich trail of micro-level data on consumers, their purchases, retailers and their offerings, auction bidding, music sharing, so on and so forth. Data mining techniques can help companies discover knowledge and acquire business intelligence from these massive datasets. This course will cover data mining for business intelligence. Data mining refers to extracting or "mining" knowledge from large amounts of data. It consists of several techniques that aim at discovering rich and interesting patterns that can bring value or "business intelligence" to organizations. Examples of such patterns include fraud detection, consumer behavior, and credit approval. The course will cover the most important data mining techniques --- classification, clustering, association rule mining, visualization, prediction --- through a hands-on approach using XL Miner and other specialized software, such as the open-source WEKA software.

MIS 535 Data Management: Technology and Applications
Introduction to fundamentals of database systems, design techniques and their use in organizations. Course covers relational database technology and focuses on design of database applications. Case studies will be used to illustrate the use of database systems for strategic and operational decision making. Emerging technologies and their applications will be covered. Students will get hands-on experience with state-of-the-art commercial relational and object-oriented database technology and learn to use SQL.

MIS 540 Introduction to Artificial Intelligence
This course is an introduction to the art and science of creating computer systems that think for themselves. We will cover techniques for representing knowledge, understanding language, building autonomous agents, computer vision and robotics. Graduate-level requirements include all undergraduate requirements, plus the completion of a substantial research project that must include a related program written by the student. There will also be separate graduate-level exams.

ECE 516 Introduction to Robotics
Kinematics of robots, dynamics of robots, robot trajectory planning, robotic vision and sensing, manipulator control, and programming robotic systems.

ECE 522 Analog Signal Processing and Filtering
Approximation of magnitude, phase and delay characteristics; design of passive, active, and switched capacitor filters; effects of op-amp parasitics; sensitivity and gain bandwidth; optimization of designs. Graduate-level requirements include additional homework and a term project.

ECE 529 Digital Signal Processing
Discrete-time signals and systems, z-transforms, discrete Fourier transform, fast Fourier transform, digital filter design. Graduate-level requirements include additional homework and a term project.

ECE 531 Image Processing Laboratory for Remote Sensing
Techniques and applications of digital image processing in remote sensing, multispectral image enhancement and analysis, classification, feature extraction for cartography, rule-based systems for mapping from imagery

ECE 532 Digital Image Analysis
Digital image analysis, including feature extraction, boundary detection, segmentation, region analysis, mathematical morphology, stereoscopy and optical flow

ECE 533 Digital Image Processing
Image transforms, filter design, spectrum estimation, enhancement, restoration, and data compression.

GEOS 534A Introduction to Exploration Seismology

Fundamental theory of seismic wave propagation, and techniques of seismic reflection and refraction data acquisition and interpretation applied to exploration of the Earth's lithospheric structure and natural resources. Study of methods to image the crust in 2-D and 3-D. Graduate-level requirements include development of an additional term project. Projects are more heavily weighted in determining the total grade.

GEOS 567 Inverse Problems in Geophysics
Linear and nonlinear inverse theory, including least squares, generalized and maximum likelihood methods.

GEOS 568 Advanced Seismology
Computational techniques in seismology. The application of synthetic seismograms to model source processes and complex structure

GEOS 569 Seismic Data Processing
Fundamental theory and practical applications of time-series analysis and digital filtering. A problem-solving approach to seismic reflection data process. Graduate-level requirements include a special research project.

AREC courses depending on amount of math