

**Graduate Handbook  
Department of Mining Engineering  
Colorado School of Mines**

**Guidelines for Graduate Studies in  
Mining and Earth Systems Engineering**

Fall 2017

The information contained in these guidelines (Mining Graduate Handbook) is intended to supplement the Graduate Student Bulletin published by the Office of Graduate Studies each academic year. The Mining Engineering Graduate Handbook presents rules, regulations, and requirements to which graduate students in the Mining Engineering Department must adhere for successful completion of their graduate degree program. It is the responsibility of each graduate student to become familiar with the general aspects of student life described in both the Undergraduate and Graduate Bulletins (<http://inside.mines.edu/Bulletins>).

The Office of Graduate Studies offers a comprehensive web site with all information and forms required to complete a degree. Students are referred to the following for that information: <http://gradschool.mines.edu/GS-Quick-Reference-Guide>.

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## 1. Overview of Mining and Earth Systems Graduate Program

The Department of Mining Engineering offers four different graduate degree options in Mining and Earth Systems Engineering:

- Master of Science – Non-Thesis (MS-NT)
  - Coursework only
  - With Engineering Report
- Master of Science – Thesis (MS-T)
- Doctor of Philosophy (PhD)

Students in these programs may specialize in Mining Engineering or in Earth Systems Engineering.

***The Mining Engineering specialty*** is for those who wish to specialize in core mining engineering disciplines such as mine planning and development, computer-aided mine design, rock mechanics, blasting and rock fragmentation, underground construction and tunneling, mine ventilation, operations research in the minerals industry, mine safety and health, environmental and sustainability considerations, mine automation and mechanization, mine valuation and project feasibility, finance and management, mine unit operations and equipment, and other similar mining engineering topics.

***The Earth Systems Engineering specialty*** is for those who wish to specialize in interdisciplinary fields that require a balanced understanding of emerging technical and social issues in Earth Systems Engineering. This specialty is also open to students with non-mining backgrounds who are interested in areas of sustainable resource extraction, small scale mining, tunneling and underground construction engineering, geothermal, explosive engineering and other emerging areas of research. Partial list of areas of research include mine reclamation, water and energy management, social and environmental issues, underground construction and tunneling, mine and construction management, mining and sustainability, and modeling and design in earth systems and processes.

In partnership with Geological Engineering and Civil and Environmental Engineering, Mining Engineering also offers the following degrees:

- Master of Science (MS) in Underground Construction and Tunnel Engineering.
- Doctor of Philosophy (PhD) in Underground Construction and Tunnel Engineering.

### **1.1. Institutional Objectives and Outcomes of Graduate Program**

Mines graduates from the Department of Mining Engineering will contribute to the advancement of their chosen fields by acquiring the skills and knowledge necessary to solve complex, open ended problems, understand decision-making processes and risk management, and apply critical thinking to resolve high level, multi-disciplinary challenges. They will also have the ability to effectively adopt and apply state-of-the-art technologies and practices in a safe and socially / environmentally acceptable manner.

### **1.2 Educational Objectives and Outcomes for the Graduate Programs in the Department of Mining Engineering**

#### **Masters of Science (MS) Program**

Educational Objectives:

1. Master's graduates will be viewed within their organizations as technologically advanced and abreast of the latest scholarship and innovations.
2. Master's graduates will exhibit the highest standards of integrity in applying scholarship.
3. Master's graduates will advance in their professions.

Educational Outcomes:

1. Graduates will demonstrate exemplary disciplinary expertise.
2. Graduates will demonstrate the ability to conduct, direct, and manage research; the ability to analyze scholarship; and the ability to apply scholarship of available and upcoming technologies in new, creative, and productive ways.
3. Graduates will demonstrate professional skills (e.g., oral and written communication, time-management, project planning, teamwork and leadership, cross-cultural and diversity competency, ethics.) necessary to succeed in a chosen career path.

#### **Doctor of Philosophy (PhD) Program**

Educational Objectives:

1. PhD graduates will make further advancements in their discipline (integrating existing knowledge and creating new knowledge) by conducting independent research that addresses relevant disciplinary and multi-disciplinary issues and by disseminating their research results to appropriate target audiences.
2. PhD graduates will be scholars who exhibit the highest standards of integrity in their research and their work will be recognized and cited by their peers on global level.
3. PhD graduates will assume positions of leadership in disciplines consistent with their career objectives and fields of study.

#### Educational Outcomes:

1. Demonstration of exemplary disciplinary expertise.
2. Demonstration of a set of skills and aptitudes usually associated with our understanding of what it means to be an academic scholar (e.g., strong technical background in the related fields of science and engineering, intellectual curiosity, intellectual integrity, ability to think critically and argue persuasively, the exercise of intellectual independence, a passion for life-long learning, capacity for interdisciplinary research).
3. Demonstration of a set of professional skills (e.g., oral and written communication, time-management, project planning, teaching, teamwork and team leadership, cross-cultural and diversity competency, etc.) necessary to succeed in a chosen career path.

### 3. Requirements for Mining and Earth Systems Engineering Degrees

#### 3.1 Academic Requirements

All credits applied toward a Mining and Earth Systems Engineering degree must be earned on campus, other than those accepted for transfer credit. A maximum of 9 credit hours from 400 level courses may be applied towards the 30 credit hour requirement. **All graduate students must maintain a minimum grade point average (GPA) of 3.0 to remain in the graduate program.**

#### 3.2 Faculty Advisor Appointments

Advisors must be fulltime “permanent” faculty members of the Department of Mining Engineering Department. In this context, full-time “permanent” members of the CSM faculty are those that hold the rank of Professor, Associate Professor, Assistant Professor, Professor of Practice, Research Professor, Associate Research Professor or Assistant Research Professor. Upon approval by the Graduate Dean, adjunct, affiliate, and teaching faculty, visiting professors, emeritus professors and off-campus representatives may be designated additional co-advisors.

Students must confirm their advisor (optional co-advisor) selection using the Thesis Committee/Advisor form available from the Graduate Office (or at <http://inside.mines.edu/GS-Committee>) **by the end of their 2<sup>nd</sup> semester**. If the student is in the MS-T program, the thesis committee must also be identified at this time. The student must submit the form to the Graduate Office for approval by the Graduate Dean. A copy must also be submitted to the Mining Engineering Department.

#### 3.3 Temporary Advisor

Each new graduate student is assigned a Temporary Advisor when admitted to the Mining Engineering Department to assist in planning the first semester of study. New graduate

students are encouraged to visit each Mining Engineering faculty member **during their first semester** to learn about their breadth of expertise and research interests.

### 3.4 Chosen Advisor

The student should select a Chosen Advisor early in the study program. All graduate students must confirm their choice for the Chosen Advisor **by the end of their 2<sup>nd</sup> semester** at CSM.

### 3.5 Co-advisor (optional)

In addition to their Mining Engineering Department advisor, students may select a co-advisor to provide additional expertise in their area of research. The co-advisor may be from the Mining Engineering Department or from a related department.

### 3.6 Minor Program

Students may choose to develop a minor focus area that may not be taken in the student's major area of study. Completion of a minor requires a minimum of 9 semester hours of course work, and designated will appear on the student's transcript. For an MS-T degree, a representative of the minor area must serve as a voting member of the Thesis Committee. For the MS-NT degree, an advisor from the minor area must be identified and approve of the courses content completed for the minor. In addition, the minor subject area along with specific courses to be taken must be proposed in writing to the student's Advisor by the student, and must be approved by the student's Advisor, his or her Report or Thesis Committee (if any), and the Mining Engineering Department Head.

### 3.7 Department Seminar

All full-time graduate students are required to participate in the Mining Engineering Department Seminar during EACH semester while in residence. Attendance will be taken and participation is expected. In the case of scheduling conflicts with other courses, and upon recommendation by the student's advisor, the requirement to participate for a single semester may be waived by the Mining Engineering Department Head.

## 4. Master of Science Degree Guidelines

Graduate students in the Department of Mining Engineering may pursue one of three Master's degree options in either the Mining Engineering or Earth Systems Engineering specialties. All Master's degree programs share the same academic requirements for grades, definition of minor programs, and the need to complete all forms including the degree audit and the appointment of advisor forms. A Master's degree at Mines requires a minimum of 30 total credit hours beyond the Bachelor of Science degree.

### 4.1 Overview of Masters Degree Options

#### Masters of Science with thesis (MS--T)

Thesis-based Masters of Science degrees require completion of a total of 30 credit hours, including a minimum of 21 credit hours of organized lecture courses and a maximum of 9 credit hours of Graduate Thesis Research (MNGN707). A maximum of 9 credit hours of the 21-credit hour requirement may be transfer credits. Transfer credits cannot be accepted if they have been used as credit toward a Bachelor degree.

- Students in the **Mining Engineering Specialty** must take a minimum of 12 course credit hours of the 21 credit hour requirement from within the Mining Engineering Department. These must include the core requirement courses listed in Appendix 2 unless waived.
- Students in the **Earth Systems Engineering Specialty** must take a minimum of 9 credit hours of the 21 credit hour requirement from within the Mining Engineering Department. These must include the core requirement courses listed in Appendix 2 unless waived.

The Thesis is expected to report on original research that results in new knowledge, techniques, or creative design that applies state-of-the-art science and engineering to solve an important problem in mining or a related field. The research must lead to a satisfactory Thesis and successful oral defense of this Thesis. This defense is made before a Thesis Committee whose members have been recommended by the student, the student's faculty advisor, and the Mining Engineering Department Head and whose appointment is made by the Dean of Graduate Studies.

The Thesis must meet the rigorous scholarship standards of the Colorado School of Mines. The student's faculty advisor and a formally appointed Thesis Committee (<http://inside.mines.edu/GS-Committee>) must approve the program of study and the topic for the Thesis. The format of the Thesis must comply with the appropriate guidelines promulgated by the CSM Graduate School. The MS-T degree is recommended for students that may decide to continue their graduate studies and enter a PhD program.

### **Master of Science non-thesis (MS-NT)**

The Mining Engineering Department also offers a Master of Science, non-thesis (MS-NT) degree. In lieu of preparing a Thesis, students are required to complete a total of 30 credits of course or project report work.

- Students in the **Mining Engineering Specialty** must take a minimum of 21 credit hours of course work from within Mining Engineering Department. These must include the core requirement courses listed in Appendix 2 unless waived.
- Students in the **Earth Systems Engineering Specialty** must take a minimum of 15 credit hours of course work from within Mining Engineering Department. These must include the core requirement courses listed in Appendix 2 unless waived.

There are two options for the MS-NT degree:

- 1) A total of 30 credit hours of course work, typically 10 organized lecture courses carrying 3 credit hours each. No transfer credit is allowed. Students are not assigned a Thesis Committee, but instead work under the supervision of their formally appointed faculty advisor (<http://inside.mines.edu/GS-Committee>).
- 2) A total of 30 credit hours, with at least 24 hours of organized lecture course work, and up to 6 credit hours of the Graduate Engineering Report course (MNGN700) to provide a project experience with a required analytical report. A maximum of 9 credit hours of the 24-credit hour requirement may be transfer credits. Transfer credits cannot be accepted if they have been used as credit toward a Bachelor degree.

The student's faculty advisor (formally appointed <http://inside.mines.edu/GS-Committee>) and a departmentally appointed Report Committee must approve the program of study and the topic for the Engineering Report. Typically, the Engineering Report covers a detailed analysis and solution of an engineering problem associated with the Mining Engineering or Earth Systems Engineering Specialties. The engineering report is not required to contain the results of original field or laboratory research, and is not required to obey all formatting requirements established for a Thesis by the Office of Graduate Studies.

Note that students with an MS degree may apply to enter a PhD program in the CSM Mining Engineering Department. However, non-thesis MS (MS-NT) degrees may not meet the requirements for research and scholarly writing expected for admission into the PhD program.

#### 4.2 Completion of Degree Audit

Full-time students are expected to complete the following requirements within one calendar year of enrolling into the Master's degree program:

- have an advisor (and thesis committee if MS-T) appointment form on file in the Graduate Office. This form must be submitted and approved prior to submitting the [Degree Audit](http://inside.mines.edu/GS-Committee) form (<http://inside.mines.edu/GS-Committee>).
- have completed all deficiencies and requirements established by the Mining Engineering Department.

For graduate degrees in the Mining Engineering Department, the determination of deficiencies is discussed in Appendix 1, and the requirements for graduate degrees are discussed in Appendix 2. Students entering the Mining Engineering Department programs with a non-mining or non-engineering undergraduate degree may delay the advisor appointment until his/her third semester.

Upon completion of the requirements defined above, students must submit a Degree audit form (<http://inside.mines.edu/GS-Committee>) documenting satisfactory completion of the deficiencies and core curriculum requirements and granting permission to begin Master's level research. The form must have the written approval of the student's Advisor and all members of the Thesis Committee (if a thesis committee is required), and must be submitted to the Office of Graduate Studies by at least **one semester before** intended graduation. The Dean of Graduate Studies officially appoints the Thesis Committee.

### 4.3 Research and Engineering Report Component for MS Degrees

This section describes the research or project experience requirement for the MS-T degree or an MS-NT degree involving an Engineering Report. An Engineering Report is similar to a Thesis with the exceptions that original field or laboratory research and thesis-compliant formatting are not required. The process is the same for both the Mining Engineering and Earth Systems Engineering specialties.

#### 4.3.1 Thesis or Engineering Report Committee Appointment

A Thesis or Report committee is required for the MS-T degree and for the MS-NT degree involving an Engineering Report. Students pursuing either degree should have a Thesis or Report committee appointed by the end of their second semester. This Committee will have a minimum of three voting members, including the student's advisor, who are familiar with the student's area of study. Two Committee members must be from the Mining Engineering Department, and all voting members must meet the full-time faculty requirement. If a Thesis or Report co-advisor is assigned, an additional faculty member from the Mining Engineering Department must be added to the Committee.

Off-campus Committee members may be assigned with voting status or in a non-voting capacity. Off-campus members with voting status assume all of the responsibilities of on-campus Committee members with respect to attendance of Committee meetings, review of Thesis or Report drafts and participation in oral examinations and Thesis or Report defense sessions. If a Thesis or Report co-advisor is assigned, an additional faculty member from the Mining Engineering Department must be added to the Committee.

Students who choose to have a minor program must select a representative from their minor area of study to serve on the Thesis or Report Committee. Minor representatives must be full-time members of the CSM faculty.

The Thesis or Report Committee Chairperson is selected following the guidelines below:

- The chairperson cannot be the student's advisor or co-advisor, and
- The chairperson must be a full-time CSM faculty member.  
The chairperson is responsible for leading all meetings of the Thesis or Report Committee and for directing the student's Thesis or Report defense.

Shortly after its appointment, and with the approval of the student's advisor, the student should arrange an initial Thesis or Report Committee meeting where the student will present orally the proposed Thesis or Report topic and course of study. The Committee and the student must agree on a satisfactory program of study and a research topic suitable for the Thesis or Report work. The student's faculty advisor assumes the primary responsibility for monitoring the program and directing the Thesis or Report work.

The student will prepare a memorandum summarizing each Committee meeting. A form available from the Graduate Office may be used for this purpose (<http://inside.mines.edu/Thesis-Committee-Report-Form>). Copies of these memoranda

shall be sent to all Committee members, the Graduate Office, and the Mining Department Office.

#### 4.3.2 Thesis or Engineering Report Proposal

The student shall prepare a written Thesis or Report proposal covering the subject selected. The student should discuss a preliminary thesis proposal with the Advisor. The Thesis or Report proposal document should include a description of the thesis problem, a literature survey, a plan of work with the major tasks identified, the original contribution, and a tentative schedule for completion. The student must obtain the Committee approval of the Thesis or Report proposal at least one semester prior to the Thesis or Report defense.

The student must schedule a full Committee meeting for the Thesis or Report proposal presentation and defense. A written copy of the Thesis or Report proposal must be distributed to Committee members at least two weeks prior to the proposal meeting. At this meeting, the student will also present course work completed, grades earned and a list of the courses planned to complete the degree requirements. Committee members will review the Thesis or Report proposal and may recommend revisions and additional course work. More than one Thesis or Report Committee meeting may be required to develop and finalize the Thesis or Report proposal. The student will prepare a memorandum documenting the Thesis or Report Committee's approval of the Thesis or Report Proposal. The Committee Report form (<http://inside.mines.edu/Thesis-Committee-Report-Form>) form may be used by Committees to document Thesis or Report Committee meetings and student progress toward degree, and Advisor and Committee assessment of progress toward degree.

Change to Thesis or Report Committee membership is discouraged once the Thesis or Report Proposal has been finalized and may be approved only if extenuating circumstances exist.

Meetings with the Thesis or Report Committee should be scheduled at least once per semester.

#### 4.3.3 Thesis or Engineering Report Writing

Based on the approved Thesis or Report Proposal, the student shall conduct the research program under the supervision of the advisor, and shall prepare a written Thesis or Report. Students may request assistance from Thesis or Report Committee members, but the final Thesis or Report may not be submitted to the Committee for review without the Advisor's approval. All thesis drafts must be prepared in accordance with thesis format instructions ([see Appendix 4](#)) and the "CSM Thesis and Dissertation Writer's Guide" available in the Graduate Office.

The Thesis or Report should demonstrate the student's ability to observe, analyze, and report on the research or project conducted. A fundamental requirement of academic work is that it should be reproducible by a competent person in the field of study. The Thesis or Report must present in detail all results obtained and all methods and processes used in the research or project. The Thesis or Report should also include a description of any

commercial software used. All materials required for reproduction of results, such as data files and computer code developed, should be discussed.

At least 4 weeks prior to the Thesis or Report defense date, the student must submit a final Thesis or Report draft to the Advisor, who will recommend necessary revisions. The Department faculty will perform thesis reviews within two weeks. It is essential that the final Thesis or Report draft is complete, technically accurate, and requires no significant grammatical revisions. The student is encouraged to engage a technical editor to correct grammatical and language problems prior to submitting a final draft.

Students may not change their Advisor after the submission of the final Thesis or Report draft.

#### **4.3.4 Thesis or Engineering Report Defense**

After completing the research, the student shall submit the final Thesis or Report draft to the Advisor. Students may not change their Advisor after the submission of the Thesis or Report draft to the Advisor for review. Following approval of the Advisor, the final Thesis or Report draft may be submitted to the full Committee for review. The student shall then schedule a thesis defense meeting, allowing all committee members at least two weeks for review. Notice of the thesis defense will be posted on departmental bulletin boards.

The initial part of the Thesis or Report defense is open to the public, and usually begins with the candidate presenting a short review of the Thesis or Report problem, the procedures followed, and the results obtained. The Committee members then question the candidate on related topics. Questions from the public will only be permitted with the approval of the Committee Chair. The second part of the defense may be closed to the public. In this part, the Committee may ask questions related to the Thesis or Report or to the candidate's academic background and specialty area of Mining Engineering or Earth Systems Engineering.

Following the defense, the Thesis or Report Committee will meet privately to vote on whether the student has successfully defended the thesis. Three outcomes are possible: the student may pass the defense; the student may fail the defense; or the Committee may vote to adjourn the defense to allow the student more time to address and remove weaknesses or inadequacies in the Thesis or Report. Two negative votes constitute a failure regardless of the number of Committee members present at the Thesis or Report defense. In the event of either failure or adjournment, the Committee Chair will prepare a written statement indicating the reasons for this action and distribute copies to the student, the Committee, the Mining Engineering Department Head, and the Graduate Dean. In the case of failure or adjournment, the student may request a re-examination, which must be scheduled no less than one week after the original defense. A second failure to defend the thesis satisfactorily will result in the termination of the student's graduate program.

#### **4.3.5 Masters Degree Completion**

Upon passing the oral defense, the student must make any corrections to the Thesis or Report required by the Committee. The final, corrected Thesis or Report including an

executed signature page must be submitted to the Graduate Office for format approval by the deadline specified by the Graduate Office. Students are responsible for following all thesis submission and checkout procedures and deadlines required for graduation, a list of which is available from the Graduate Office (<http://inside.mines.edu/Graduation-Checklist>).

## 5. PhD Guidelines

These guidelines clearly establish the expectations to be achieved by all PhD graduate students in the Department of Mining Engineering at the Colorado School of Mines. The Mining Engineering faculty as a whole has the ultimate responsibility for primary oversight in ensuring the integrity of the graduate program. These guidelines offer a clear explanation of the procedures associated with student milestones including; admissions, qualifying assessment, course requirements, comprehensive examinations, and the completion of the program with the dissertation defense.

The appointment of a Qualifying Assessment Committee (QAC) comprised of faculty members from the Mining Engineering Department, is key in the PhD program administration. Chosen by the Department Head, the QAC will be comprised of at least four faculty members who are either part of the tenured/tenure track faculty or are full-time Professors of Practice. The QAC will be appointed before the start of each Fall semester, and will include at least one member who holds the rank of Full Professor. The chair of the QAC will be appointed by the Department Head.

A successful PhD student must achieve the milestones described below.

### 5.1 Admission to the Mining and Earth Systems Engineering PhD program

- a) The GRE exam is required for all applicants unless they have received an engineering degree (B.S. or M.S.) from Mines within five (5) years of applying for admission into a graduate program of study.
- b) Each PhD student admitted will be assigned a Temporary Advisor, unless a Chosen Advisor identified during the admission process has accepted responsibility for advising the student. Student will choose a permanent advisor before they begin their dissertation research.
- c) Deficiencies [Note: a listing of coursework required to be completed by a student in pursuit of a PhD degree in Mining and Earth Systems Engineering is summarized in a table in Appendix 3 to these guidelines.]
  - Accepted PhD students who have received an ABET-accredited B.S. degree in Mining Engineering or who hold a PE in Mining Engineering will be admitted without deficiencies.
  - Accepted PhD students who have received a non-ABET-accredited B.S. degree in Mining Engineering will likely be admitted without deficiencies pending review of their undergraduate transcript. Any concerns about potential deficiencies will be resolved through consultation of the QAC with the Temporary or Chosen Advisor before registration for first semester classes.
  - Accepted PhD students who have received a B.S. degree in an engineering discipline other than Mining Engineering will likely possess deficiencies in Mining Engineering preparation. These deficiencies will be identified through consultation between the Temporary or Chosen Advisor and the QAC and communicated by

email to the applicant prior to their arrival on campus. A plan to address such deficiencies will be identified in this communication.

- Accepted PhD students without an engineering B.S. degree will likely possess deficiencies related to courses fundamental to both general and mining engineering. These deficiencies will be identified through consultation between the Temporary or Chosen Advisor and the QAC and communicated to the applicant by email prior to their arrival on campus. A plan to address such deficiencies will be identified in this communication.
- d) An admitted PhD student may submit a request to the QAC seeking to address the deficiencies by:
- Successfully completing the required courses, or
  - Applying to “test out” of one or more of the identified deficiencies. The “test-out” exam questions in any particular subject will be derived from FE/EIT study exams and/or developed by the QAC in consultation with the Temporary Advisor. A requested “test-out” exam for each deficiency will be administered by the QAC.

## 5.2 The First Year and the Qualifying Assessment (QA)

- a) Prior to beginning their first semester, each student will meet with his/her advisor to establish coursework to be taken during the first two semesters of study and begin to investigate potential dissertation topics and sources of funding. This meeting will include a discussion of deficiencies, the plan to complete the QA, career objectives, departmental expectations, and student responsibilities. Students are encouraged to meet with all faculty members to explore research opportunities and discuss research interests.

A student’s plan for coursework must acknowledge that there is an CSM institutional credit requirement of 24 research credits minimum and 30 course credits minimum, and a combined graduate credit minimum of 72 beyond the Bachelor’s degree. These totals may include transfer credits

- b) Each PhD student is required to complete a “Qualifying Assessment” (QA) that is designed to:
- identify knowledge gaps that should be addressed to enhance the likelihood for success in their chosen area of research;
  - assess his/her ability for critical thinking, including review, synthesis, and application of fundamental concepts in Mining and Earth Systems Engineering;
  - determine the creative and technical potential of the student to solve open-ended and challenging problems in a research context; and
  - evaluate the student's technical communication skills.

The QA will be developed and administered by the QAC in consultation with the Temporary Advisor, and the assessment will be framed to the context of the student’s intended area of study. The QA will include written and oral portions, including preparation of summaries for assigned journal papers and critical discussions of paper content.

The QA is not a pass/fail assessment. Rather, it is aimed to provide guidance for the Temporary Advisor and the QAC in selecting appropriate strategies/coursework to rectify

identified shortcomings. The QAC and Temporary Advisor will prepare a communication in writing to establish coursework and additional preparation that must be completed by the student before development of a dissertation proposal and admission to PhD candidacy. Once formed, the candidate's dissertation committee may also require the candidate to successfully complete additional courses as part of his/her degree program.

It is expected that the QA will be offered twice each year, once during each of the Fall and Spring semesters. It is expected that the QA will be completed during the student's first semester. However, this assessment may be delayed to the second semester if an approved request is made in order to fulfill deficiencies. The QAC is encouraged to develop example problems and distribute them to the PhD students before the assessment is administered.

- c) At the conclusion of the first semester, each student will meet with either his/her Temporary Advisor or with another faculty member who has agreed to serve as the student's Chosen Advisor for the PhD program. At this meeting, the outcomes from the QA will be discussed, the student's academic progress will be reviewed, future coursework will be identified, and possible dissertation topics (including preliminary literature reviews) and sources of funding will be discussed.
- d) Prior to the end of the student's second semester, each student must have identified a Chosen Advisor who has agreed to supervise his/her PhD work. The agreement between the student and the Chosen Advisor must be documented by submitting the completed and signed Form MN-1 (Appendix 3) to the Program Assistant in the Department of Mining Engineering.

### **5.3 Admission to PhD candidacy in Mining and Earth Systems Engineering**

- a) By the start of the third semester, the advisor and student will meet to assess academic progress and to plan future coursework and research. The discussion on a viable dissertation topic should be advanced enough to include a concept narrative, a potential research methodology, and a detailed literature search. When relevant, funding sources should also be discussed and reviewed. A PhD Committee should also be selected.
- b) During the third semester, an initial meeting of the PhD Committee should be convened during which the student presents a preliminary proposal of research, a review of courses and academic performance, and a schedule with research milestones. The student will be given a guidance from the PhD Committee on research, future academic coursework, funding, and other preparation.
- c) During the final semester of registration for required courses (typically in the 3<sup>rd</sup> or 4<sup>th</sup> semester), the student should prepare and defend a complete research proposal to the PhD Committee. At this meeting, the student should present their "Degree Audit" for approval of the PhD Committee (<http://inside.mines.edu/Degree-Audit>). A Comprehensive Exam (CE) should be scheduled at that time to be conducted before the end of the following semester.
- d) The Comprehensive Exam (CE) will be conducted by the PhD Committee and is generally expected to include an oral and written part and should be completed before the end of the student's fourth semester in residence. The written part may be waived by the PhD

Committee at its discretion. For the oral CE, each member of the PhD Committee may ask questions focused on the student's areas of expertise as defined by the coursework taken, their research topic, and professional history. Each Committee member will vote as to whether the student has passed or failed in answering their questions. The student passes the CE if a simple majority of the PhD Committee members vote to pass.

If a student fails either the oral or written exam, the PhD Committee will develop and administer an academic plan for the student to address the required modifications to the proposed work and remedy deficiencies identified by the committee. The PhD Committee will administer a second CE no sooner than 6 months after the first CE. In the event the student fails a portion of the second CE, the student will be dismissed from the PhD program.

- e) If the Proposal Defense is successful, and the CE has been passed, the student is eligible to apply for Admission to Candidacy (<http://inside.mines.edu/Admission-to-Candidacy-form>).

#### 5.4 Dissertation Defense and Award of Degree

At the conclusion of his/her academic program, including completion of the proposed research, the PhD candidate presents his/her dissertation ([see Appendix 4 for formatting options](#)) to the PhD Committee no later than three (3) weeks prior to the oral defense. At the oral defense the candidate defends his/her research and dissertation to the PhD Committee, faculty, and other members of the public. Committee and members of the public may ask the Candidate questions to defend his/her research findings. The success of the defense is determined by a simple majority of the PhD Committee membership. The candidate will finalize the document as directed by the PhD Committee, and submit the dissertation to the Graduate School for formatting review.

To complete the process for degree award, the web site <https://inside.mines.edu/Graduation-Checklist> provides information on the administrative steps for graduation.

#### 5.5 Additional Notes

- a) Note that by Mines' Parental Leave policy (<http://inside.mines.edu/Parental-Leave-of-Absence>), a qualifying student will receive a one-semester extension of all academic requirements (e.g., QA, CE, proposal defense, time to degree limitations, etc.), and such a student will maintain full-time status in degree program while on Parental Leave.
- b) For a part-time student, the defense of the dissertation proposal may be completed as late as the end of the 6<sup>th</sup> semester in the program.
- c) Colorado School of Mines Policies and Graduate Guidelines supersede the provisions of this handbook in case of a conflict.

### 6. Other Pertinent Information

#### 6.1 Graduate Seminar

All full-time graduate students are required to register and participate in the Graduate Mining Seminar during EACH semester while in residence. In the case of scheduling conflicts with other courses, and upon recommendation by the student's advisor, the requirement may be waived for a single semester by the Mining Engineering Department Head.

## 6.2 Financial Assistance

CSM and the Mining Engineering Department have limited funds for supporting Teaching and Research Assistants and for providing scholarships and fellowships for graduate study. For students that did not receive a financial aid offer at admission, there may be other sources of financial support available from mining, tunneling and underground construction companies, the CSM's Financial Aid Office, and/or the office of Graduate Studies. *It is important to note that the acceptance for graduate study does not imply a promise of financial aid. The Mining Department is selective in offering financial assistance to students.* Types of financial aid provided by the Mining Engineering Department may include industrial fellowships, teaching assistantships, and hourly employment with the Earth Mechanics Institute, the Edgar Experimental Mine, or the department's main office. Graduate students seeking departmental aid during the semester or summer should direct their inquiries to the Department Head. For more information, visit the CSM Financial Aid website at: <http://inside.mines.edu/General-Information>.

## 6.3 Graduate Student Organizations

The Graduate Student Association (GSA) is open to all graduate students. Graduate students in the mining department elect a Graduate Student Representative, who represents the department's graduate students at the monthly GSA meetings. There are opportunities to shape student policy and petition for financial support of social activities and travel to industry meetings and conferences. Additional information regarding the GSA can be found at: <http://inside.mines.edu/GS-Graduate-Student-Association>.

Other student body organizations, such as the Student Chapter of the Society for Mining, Metallurgy, and Exploration (SME), are active in academic and industry affairs. It is recommended that graduate students join the SME Student Chapter during their first semester of their studies. The International Society of Explosive Engineers (ISEE) has an active Student Chapter within the Department, and The Underground Construction Association (UCA) of SME has a student chapter on campus (which has a seminar-with-lunch twice a month for interested students). These societies offer students opportunities to network with local industry leaders and participate in technical activities and events that promote professional development through monthly and annual meetings. Additional information regarding student organizations can be found at: <http://mining.mines.edu/Mining-Student-Organizations>.

**APPENDICES**

**Appendix 1****Deficiencies and Provisional Status**

The Mining Engineering Department may accept a graduate student with deficiencies. Such students will be admitted as provisional. At the start of the student's first semester, the Mining Engineering Department Head will provide provisional students with a list of courses required to remove their deficiencies.

If the student demonstrates satisfactory performance, provisional status may be removed and full enrollment status attained after the first semester. Provisional status may not be extended for more than 12 months. For details, please refer to the Graduate Bulletin.

Satisfactory performance requires a grade of "C" or better in deficiency courses, and a grade of "B" or better in graduate level courses. Failure to earn a grade of "C" or better in a deficiency course may result in dismissal from the graduate program. Completion of specific deficiency courses may be required before attempting graduate level courses where such background knowledge is expected.

<b>Course List for the Evaluation of Core Curriculum Deficiencies, Mining Engineering Specialty</b>		
<b>Course Number</b>	<b>Description</b>	<b>Semester Hours</b>
MNGN210	Introductory Mining	3
MNGN312	Surface Mine Design	3
MNGN314	Underground Mine Design	3
MNGN316	Coal Mining Methods and Design	3
MNGN321	Introduction to Rock Mechanics	3
MNGN414	Mine Plant Design	3
MNGN424	Mine Ventilation	3
MNGN427	Mine Valuation	2
MNGN433	Mine Systems Analysis (an equivalent Systems or Operations Research course is acceptable)	3
MNGN438	Introduction to Geostatistics	3
GEOL311	Structural Geology	2
GEOL310	Earth Materials and Resources (an equivalent mineralogy or mineral deposit course is acceptable)	4
MATH111	Calculus for Scientists and Engineers I	4
MATH112	Calculus for Scientists and Engineers II	4
MATH213	Calculus for Scientists and Engineers III	4
MATH225	Differential Equations	3
PHGN100	Physics I: Mechanics	4.5
PHGN200	Physics II: Electromagnetism and Optics	4.5
CHGN121	Principles of Chemistry	4
CEEN241	Statics	3
MNGN317	Dynamics for Mining Engineers	1
MEGN361	Thermodynamics	3
MEGN351	Fluid mechanics	3
CEEN311	Mechanics of Materials	3
EEGN281	Introduction to Electrical Circuits, Electronics and Power	3
EBGN201	Principles of Economics	3
(varies)	Technical writing	3

<b>Course List for the Evaluation of Core Curriculum Deficiencies, Earth Systems Engineering Specialty</b>		
<b>Course Number</b>	<b>Description</b>	<b>Semester Hours</b>
MNGN210	Introductory Mining	3
MNGN312	Surface Mine Design	3
MNGN314	Underground Mine Design	3
MNGN321	Introduction to Rock Mechanics	3
EGGN361	Soil Mechanics	3
EGGN464	Foundations	3
GEOL311	Structural Geology	2
GEOL310	Earth Materials and Resources (an equivalent mineralogy or mineral deposit course is acceptable)	4
MATH111	Calculus for Scientists and Engineers I	4
MATH112	Calculus for Scientists and Engineers II	4
MATH213	Calculus for Scientists and Engineers III	4
MATH225	Differential Equations	3
MATH323	Probability and Statistics for Engineers	3
PHGN100	Physics I: Mechanics	4.5
PHGN200	Physics II: Electromagnetism and Optics	4.5
CHGN121	Principles of Chemistry	4
CEEN241	Statics	3
MEGN351	Dynamics	3
MEGN361	Thermodynamics	3
MEGN351	Fluid mechanics	3
CEEN311	Mechanics of Materials	3
EEGN281	Introduction to Electrical Circuits, Electronics and Power	3
EBGN201	Principles of Economics	3
(varies)	Technical writing	3

Course Number	Description	Alternative	<400 level	400 Level CH	Grad Semester Hours
MNGN312	Surface Mine Design	Or Advanced Surface Mine Design	x		3*
MNGN314	Underground Mine Design	Or Advanced Underground Mine Design	x		3*
MNGN323	Mineral Processing	MTGN532 Comminution and Physical Separations and/or MTGN533 Applied Separations	x		x
MNGN321	Introduction to Rock Mechanics	Or Advanced Rock Mechanics	x		3*
MNGN414	Mine Plant Design			3	
MNGN424	Mine Ventilation	Or Advanced Ventilation	x		x
MNGN427	Mine Valuation			2	
MNGN433	Mine Systems Analysis	Or an equivalent Systems or Operations Research 500 level course		x	x
MNGN438	Introduction to Geostatistics			3	
MNGN/Other	Electives				6 to 9
CEEN241	Statics		3		
MNGN317	Dynamics for Mining Engineers		1		
MEGN361	Thermodynamics		3		
MEGN351	Fluid mechanics		3		
CEEN311	Mechanics of Materials		3		
EEGN281	Introduction to Electrical Circuits, Electronics and Power		3		
EBGN201	Principles of Economics		3		
Geology	Physical, Mineral Deposits, Engineering Geology, Structural		6 - 10		
	In addition, Math through Differential Eq.		25 - 29		

\*Two of these three courses must be taken at the graduate level

**APPENDIX 2****Mining Engineering Department Course Requirements**

All graduate students must complete two of the three courses listed below, usually during their first academic year of study at CSM. These courses are:

MNGN505	Rock Mechanics in Mining
MNGN512	Surface Mine Design
MNGN516	Underground Mine Design

If the student has satisfactorily completed one or more of these required courses in a previous degree program, this requirement for that course or courses may be waived.

**Appendix 3**



DEPARTMENT OF MINING ENGINEERING

**Form MN-1  
Formal Notification of Chosen Advisor for the PhD Program**

Date of notification: \_\_\_\_\_

The following faculty member:

\_\_\_\_\_  
(print name)

Agrees to serve as the Chosen Advisor and research supervisor for the PhD program of the following student:

\_\_\_\_\_  
(print name)

Student Signature: \_\_\_\_\_

Chosen Advisor Signature: \_\_\_\_\_

Approved: \_\_\_\_\_  
(Department Head, Mining Engineering)

Form to be submitted to the Program Assistant for the Department of Mining Engineering in BB239 by the close of business of the last day of classes during the student's second semester.

## Appendix 4

The MN Department permits thesis/dissertation formats in either of the two options below, in accordance with the guidelines established by the Office of Graduate Studies. The format style should be selected at the discretion of the advisor and committee members.

### A: Classic Monograph Format

#### Ch 1. Introduction

#### Ch 2. Methods (experiments 1-3)

#### Ch 3. Results (experiments 1-3)

#### Ch 4. Discussion (experiments 1-3)

#### Ch 5. Conclusions, references

#### Appendices

### B: Modified Monograph Format

#### Ch 1. Overarching introduction & background

#### Ch 2. Paper 1 based on experiment 1

- Intro, methods, results, discussion, conclusions, references

#### Ch 3. Paper 2 based on experiment 2

- Intro, methods, results, discussion, conclusions, references

#### Ch 4. Paper 3 based on experiment 3

- Intro, methods, results, discussion, conclusions, references

#### Ch 5. Conclusions linking all 3 experiments, broader implications, future work

#### Appendices