COLORADOSCHOOLOFMINES
EARTH • ENERGY • ENVIRONMENT

Engineering Graduate Handbook

Masters and Doctoral degrees in Engineering

with specialties in

Civil Engineering
Electrical Engineering
Engineering Systems
Mechanical Engineering

Colorado School of Mines
August 2009

INDEX

Use of Guidelines

This document describes guidelines for graduate programs in the Engineering Division and does not replace the official school requirements stated in the CSM Graduate Bulletin for the year the student enters into the program. Students, at their discretion, may officially request a change in the bulletin year that governs their degree. The bulletin year for a student can change from the year that they entered the program to any subsequent year but the graduation requirements associated with the new bulletin are applied in their entirety

Course substitution requests and graduate level transfer requests are granted by the Division Director on the recommendation of the student's thesis committee. For students that are pursuing a non-thesis degree or if a committee has not been formed, this recommendation must come from the student's faculty advisor.

It is recommended that the student carefully read the requirements in the CSM Graduate Bulletin. Please consult with your Advisor if you have any questions.

Overview of the Engineering Graduate Programs

Welcome to the Engineering Division at the Colorado School of Mines. We offer M.S (Thesis and non-Thesis options) and Ph.D. programs with specialty areas in Civil Engineering, Electrical Engineering, Engineering Systems, and Mechanical Engineering. The Division encourages an interdisciplinary approach to graduate education that offers graduate students a wide range of options to tailor their individual programs.

Dr. Terry Parker is the Engineering Division Director with responsibility for the overall direction of the Program. The Division Graduate Committee consists of Dr. Vaughan Griffiths (Civil Engineering, Tel: 303 273 3669, d.v.griffiths@mines.edu), Dr. Katie Johnson (Electrical Engineering, Tel: (303) 273-3914, kjohnson@mines.edu), Dr. John Steele (Engineering Systems, Tel: (303) 273-3663, jsteele@mines.edu) and Dr. Paul Papas (Mechanical Engineering, Tel: (303) 273-3655, ppapas@mines.edu) who may be contacted for further information about the specialty areas.

- The Engineering office is situated in Brown Hall room BB 269
- The Engineering Division web site is located at http://engineering.mines.edu/
- Useful forms for graduate students can be found at:

  http://inside.mines.edu/admiss/grad/info_current_students.htm

- Tuition, fees, and heath insurance costs can be found at:

  http://www.mines.edu/Costs_GS

Getting Started

Temporary and Permanent Graduate Advisor – When you are admitted to the Engineering graduate program, you will be assigned a temporary Advisor. Please contact your advisor to determine if she/he will be hosting a general meeting of the new graduate students in your specialty and to arrange to meet with you advisor to discuss your academic program. Thesis-based Masters and Doctoral students must identify a research topic and permanent thesis Advisor in their first two semesters of study and preferably as soon as possible. Whether you are thesis or non-thesis based, it is quite likely that by the end of your first semester you will change to a permanent Advisor who will work with you for the remainder of your graduate studies. The Engineering office has the form needed to change your Advisor.

Graduate Student Offices. Mailboxes and Keys – The Engineering Division front desk will be able to advise you how to get a desk in one of the graduate offices, assign a mailbox and start any paperwork needed to obtain any necessary keys. Desk space is usually allocated only to thesis-based students.

Trailhead – Trailhead is a web-site that serves as that school's single entry point for fast and easy access to information pertinent to currently enrolled students, faculty, staff, and employees. For example, students can register for courses, check e-mail, access Blackboard, maintain a personal calendar and participate in portal groups. Please note that this site will

continue to be a work-in-progress for the next several years. Watch for new additions, channels and updates. To register for the first time login go to http://newuser.mines.edu/trailhead/ You will need your username and EKey to set your Trailhead password. Need help or have a question? Email trailhead@mines.edu.

What can Trailhead do for me?

- register for classes
- manage my calendar
- access library resources
- learn about campus events
- check the weather
- read the latest news headlines
- receive announcements
- view records
- store information
- chat with peers
- access financial aid info…and much more...

Blackboard – The CSM Blackboard system (http://blackboard.mines.edu) is used for presentation of course materials via the Internet. Students enrolled into the Blackboard portion of a CSM course can access online course materials, assignments, quizzes, grades and discussion boards from any internet access point.

Copy Cards and Printing – Nearly all campus copy machines use the BlasterCard which can be credited with money by the Student Life Office. Paid Teaching Assistants (TA) and Research Assistants (RA) within the Division get a budget for printing while all other graduate students must support their own printing costs. Printer accounts and a list of available printers within the Division can be obtained from Harry Tran.

Registration for Classes – the online Course Schedule is the most up-to-date list of classes. After discussion with your Advisor, you can register online. Steps to register for a class are given below.

1. Log onto Trailhead
2. Select the Self Service Banner button (upper right corner)
3. Click on the Student and Financial Aid tab
4. Choose the Registration link.
5. Select the Add/Drop link. Select the term.
6. Enter the CRN (course registration number) for each course you wish to register for.
7. If you receive an error please visit the help menu for information.
8. Review your schedule.

Selection of a Thesis Committee - Thesis-based students require a Thesis Committee that should be appointed by the end of their second semester. See the CSM Graduate Bulletin for the rules concerning the Committee appointment and membership. The form for filing a Thesis Committee (and other forms) can be found at
http://inside.mines.edu/admiss/grad/info_current_students.htm

After securing agreement from each potential member, prepare the Thesis Committee form. This form is to be initialed by each committee member and the Division Director. The form is then filed with the EG Division Office who will forward a copy to the Graduate Office for approval by the Dean of Graduate Studies. After processing, the Graduate Office will return an official stamped copy. The purpose of your thesis committee is to provide you with guidance during the course of your program. While the Advisor controls the direction of your research program, the other members of your committee may give very valuable assistance. After planning your research project, set up a meeting with your thesis Advisor and committee to present your plan. A timetable for the completion of your thesis should be presented, discussed, and approved.

The Division has put the following procedure in place to ensure that thesis-based students connect with an Advisor within the two-semester time frame:

1. It is the responsibility of the temporary Advisor to advise the student on how to select a research topic and thesis Advisor. This means the temporary Advisor will communicate with the student and establish a plan with the student to investigate areas of research.

2. An administrative assistant in the EG Division Office will maintain the following data: Student Name, Degree, Thesis/Non-thesis, Date of Acceptance for the degree, Advisor Name, Date Advisor/Committee Form approved.

3. By the end of the second week in every academic-year semester (fall and spring semesters only), the EG administrative assistant will determine which students have been enrolled for at least two academic year semesters and do not have an approved Advisor/committee form.

4. The administrative assistant will send an email to the temporary Advisor with the names and e-mail addresses of students that do not have an approved Advisor/committee form in the EG Division files. The temporary Advisors will send an e-mail to the students stating that a registration hold will be placed on their account until a thesis committee form that shows an Advisor is completed.

Financial Aid

The Engineering Division is in some cases able to provide financial aid for its full-time graduate students. Support is most often available in the form of Teaching Assistant (TA) and Research Assistant (RA) appointments. The amount and financial aid conditions when applicable are clearly specified in your acceptance letter. Normally, financial aid is not offered to provisionally accepted students or non-thesis MS students. If a non-thesis MS student decides to switch to the thesis option, he or she may become eligible for financial aid and their thesis Advisor should inform the Division of this change of status so that the student can be considered for aid as it becomes available.

Summer Registration

Students working on their thesis-based degree and utilizing CSM facilities during the summer must register for a minimum of 3 research credit hours and they must also arrange for payment of summer session fees. Health insurance is also available to summer session students. Students that paid the health insurance in the previous spring will not have to pay (or have the research contract pay) health insurance in the summer. In addition, students can waive the health insurance under certain conditions. . If a student registers for more than the 3 research credit hour minimum their tuition for the semester will increase and the student must identify a funding source for the increased tuition. .. Students who start their graduate education during the summer must pay both summer fees and health insurance unless they are attached to some research project, fellowship, or grant that might pay these costs.

Student Fees and Health Insurance

All graduate students registering for 3 or more hours will be assessed mandatory student fees and assessed a health insurance fee at the time of registration. The health insurance fee can be waived by providing the Registrar's Office with proof of other insurance.

Please contact the Office of Graduate Studies, either Brenda Neely (303-273-3412) or Diane Mee (303-273-3627) if you have questions.

Graduate Programs in Engineering

Degrees Offered

Master of Science (Engineering, Thesis and non-Thesis options)

Doctor of Philosophy (Engineering)

Program Overview

The Engineering program offers a multidisciplinary graduate education **with an option to specialize in—Civil, Electrical, Engineering Systems or Mechanical Engineering**. The program demands academic rigor and depth yet also addresses real-world problems in advanced engineering and technology. The Division of Engineering has eight areas of research activity although in some cases, individual research projects may encompass more than one research area.

Research Areas

Geotechnical Engineering has current activity in computational and analytical geomechanics, probabilistic geotechnics, experimental and theoretical investigations into coupled flows and unsaturated soil behavior, and intelligent geo-systems including geo-construction sensing and automation. The geotechnical faculty and students work primarily within the Civil Specialty of the Engineering graduate programs, however strong interdisciplinary ties are maintained with other groups in Engineering and other Departments at CSM.

Structural Engineering focuses on frontier, multidisciplinary research in the following areas: high strength and self consolidating concrete, experimental and computational structural dynamics, vibration control, damage diagnosis, and advanced data processing and analysis for sensory systems, disaster assessment and mitigation, and structural nondestructive evaluation.

Sensing, Communications and Control is an interdisciplinary research area that encompasses the fields of control systems, wireless communications, signal and image processing, robotics, and mechatronics. Focus areas include adaptive and nonlinear control, intelligent and learning control systems, fault detection and system identification, wireless communication circuits, computer vision and pattern recognition, sensor development, mobile manipulation and autonomous systems. Applications can be found in renewable energy and power systems, materials processing, sensor and control networks, bio-engineering, intelligent structures, and geosystems. Participating graduate students come from a variety of backgrounds, and may specialize in civil, mechanical or electrical engineering, or engineering systems.

Energy Systems and Power Electronics is focused on both fundamental and applied research in the interrelated fields of conventional electric power systems and electric machinery, renewable energy and distributed generation, energy economics and policy issues, power quality, power electronics and drives. The overall scope of research encompasses a broad spectrum of electrical energy applications including investor-owned utilities, rural electric associations, manufacturing facilities, regulatory agencies, and consulting engineering firms.

Biomedical Engineering focuses on the application of engineering principles to the musculoskeletal system and other connective tissues. Research activities include experimental, computational, and theoretical approaches with applications in the areas of computer assisted surgery and medical robotics, medical imaging, patient specific biomechanical modeling, intelligent prosthetics and implants, bioinstrumentation, and supermolecular biomaterials. The Bioengineering group has strong research ties with other campus departments, the local medical community, and industry partners.

Energy Conversion Systems and Thermal Sciences is a research area with a wide array of multidisciplinary applications including clean energy systems, materials processing, and combustion. d. Graduate students in this area typically specialize in Mechanical Engineering but also have the opportunity to specialize in interdisciplinary programs such as Materials Science.

Mechanics of Materials investigations consider solid-state material behavior as it relates to microstructural evolution and control, nano-mechanics, functionally graded materials, biomaterial analysis and characterization, artificial biomaterial design, and fracture mechanics. Research in this area tends to have a strong computational physics component covering a broad range of length and time scales that embrace ab initio calculations, molecular dynamics, Monte Carlo and continuum modeling. These tools are used to study metallic and ceramic systems as well as natural biomaterials. Strong ties exist between this group and activities within the campus communities of physics, materials science, mathematics and chemical engineering.

Robotics is a multidisciplinary research area drawing from mechanical engineering, electrical and electronic engineering, and computer science. The focus is on developing intelligent machines that are adaptive, dexterous, and useful. Robotics research includes exploring perception,

manipulation, and machine intelligence. Students working in this area tend to focus on robot design, advanced robot control, perception, and system integration. Areas of study include kinematics and dynamics of robots, robot motion planning, design and implementation of embedded systems, world modeling from perception, and fundamental studies of dexterous manipulation. Applications include industrial manufacturing, mining, material handling, security and safety, and service industries.

Admission Requirements

The minimum requirements for admission to the M.S. and Ph.D. degree programs in Engineering are (i) a baccalaureate degree in engineering, computer science, a physical science, or math with a grade-point average over 3.0 and (ii) a Graduate Record Examination (GRE) score of 650 (math) and a TOEFL score of 550 or higher (paper based), 213 (computer based) for applicants whose native language is not English. Applicants from an engineering program at CSM are not required to submit GRE scores.

The Engineering Graduate committee evaluating an applicant may require that the student take undergraduate remedial coursework, to overcome technical deficiencies, which does not count toward the graduate program. Deficiencies of this kind will vary according to the specialty area in which the applicant wishes to pursue graduate studies as well as the applicant's technical training. The committee will decide whether to recommend to the Dean of Graduate Studies regular or provisional admission, and may ask the applicant to come for an interview.

Program Requirements

EGGN 504: Engineering Seminar All Engineering graduate students are required to take this 1 credit hour seminar course. Each specialty has its own requirements, but the course typically requires students to attend and report on a certain number of seminars and possibly present one themselves to the other students. Students are encouraged to enroll in EGGN 504 as soon as they start their graduate studies, but they should only enroll once. It is unusual for a student to complete the requirements for this course in a single semester, in which case the professor in charge will return a grade of "PRG" meaning progress towards completion. A grade change form will be submitted to the Registrar when all requirements for this course have been completed.

Senior Level Credit As stipulated by the CSM Graduate School, up to nine 400-level (Senior level) credits of course work may be counted towards any graduate degree if they have not already been counted as part of the requirements of an undergraduate degree. Note that these credits must satisfy a requirement of the student's degree program.

Independent Study Credits Independent Study (EGGN 599) course units (up to a maximum of 6 credit hours) can be used to fulfill degree requirements, however the allowance varies between specialty areas.

Minimum Grade Requirement All graduate students at CSM must maintain an average GPA of at least 3.0 (B grade). Students who fall below this threshold will be required to produce a Remedial Plan that must be agreed by the faculty Advisor, the Division Director and the Dean of Graduate Studies. The remedial plan will be coordinated by the faculty Advisor and take the form of a memorandum in which the student outlines how he or she plans to improve their future performance

and to increase their average GPA. The remedial plan will also include a statement of any additional work that must be performed in those courses where the grade fell below a B.

Master of Science (M.S.)

The M.S. Engineering degree (Thesis or non-Thesis option) requires 30 credit hours. Requirements for the Thesis option are 24 hours of coursework and 6 hours of thesis research. The non-Thesis option requires 30 hours of coursework.

In addition, the Division of Engineering in collaboration with the Departments of Physics and Chemistry at CSM offers five-year programs in which students have the opportunity to obtain specific engineering skills to complement their physics or chemistry background. The Physics five-year program offers tracks in Electrical Engineering and Mechanical Engineering. Details on these five-year programs can be found in the CSM Undergraduate Bulletin. Course schedules for these five-year programs can be obtained in the Engineering, Physics and Chemistry Departmental Offices.

Students must have an Advisor from the Engineering Division Graduate Faculty to direct and monitor their academic plan and, in the case of the Thesis option, their research. Master of Science (Thesis option) students must have at least three members on their graduate committee, two of whom must be permanent faculty in the Engineering Division.

Admission to Candidacy

Full-time students should complete the following requirements within one year after enrolling in the M.S. program.

- Have a Thesis Committee (Thesis option) or permanent faculty Advisor (non-Thesis option) form on file in the Graduate Office;
- Complete all core courses in their chosen specialty

Upon completion of these requirements, students must complete an Admission to Candidacy form, which can be obtained from http://inside.mines.edu/admiss/grad/info_current_students.htm This form must be signed by the Thesis Committee (thesis based degree) or Advisor, the Engineering Division Director, and filed with the Graduate Office. Successful Admission to Candidacy documents the students planned degree program and is a significant milestone. . Further details are available in the Graduate Bulletin.

Doctor of Philosophy (Ph.D.)

The Ph.D. Engineering degree requires 72 credit hours consisting of 48 hours of coursework and 24 hours of thesis research. Ph.D. graduate committees must have at least four members in addition to the Advisor (or co-Advisors) including a minor Advisor and one other who will both be from an outside department. Refer to the Section on Graduate Degrees and Requirements in the CSM Graduate Bulletin for a more detailed description of the committee membership.

Transfer Credits Students who have previously obtained an M.S. degree in engineering, computer science, a physical science or math from another university may transfer up to 30 credit hours towards their Ph.D. coursework requirement according to the following guidelines:

a. Course grades must be a B or higher
b. The upper limit for transfer credit is set to 30 credit hours for an M.S. degree.
c. Transfer credits can count toward a core course, a minor course, or a technical elective.
d. Up to 9 senior-level undergraduate courses may be counted with a grade B or higher if they have not already been counted as part of the requirements of an undergraduate degree.
e. The thesis advisor, in consultation with the thesis committee and Division Director, will determine which degree requirements have been met by the student's M.S. degree.

A student receiving full M.S. credit of 30 hours will thus need to complete a minimum of 18 further credit hours of coursework and 24 hours of thesis research.

Students who completed their M.S. at another university or another department at CSM must complete a transfer credit request form, which may be obtained from the Engineering Office. The form should indicate the courses for which credit is being requested and be accompanied by a copy of the official academic transcript from the university or department from which the M.S. was received. Approval of the transfer credit request must be obtained from the Faculty Advisor, the Thesis Committee, and the Division Director, and will be based on acceptable course mapping in relation to the published requirements of the student's Ph.D. specialty area (see Engineering Specialty Course Requirements in this Handbook).

At the discretion of the student's Advisor and Division Director, students who previously completed their M.S. degree within the Engineering Division and who return for a Ph.D. will not usually be required to complete a transfer request form and will be permitted the full 30 hours of transfer credit. In this case, courses will fill requirements of the student's Ph.D. program as appropriate.

Students who obtain an M.S. degree at CSM in the Division of Engineering with no break in enrollment may continue on to their Ph.D. program without the need to submit a transfer credit request form; in this case, courses taken for the M.S. degree may be used to fulfill Ph.D. degree requirements.

Ph.D. Qualifying Exam Students wishing to enroll in the Engineering Ph.D. program will be required to pass a Qualifying Exam. Normally, full-time Ph.D. candidates will take the Qualifying Exam in their first year, but it must be taken within three semesters of entering the program. Part-time candidates will normally be expected to take the Qualifying Exam within no more than six semesters of entering the program.

The purpose of the Qualifying Exam is to assess some of the attributes expected of a successful Ph.D. student. Each specialty area (Civil, Electrical, Engineering Systems and Mechanical)

will administer their own Ph.D. Qualifying Exams, however the agreed objectives are to assess the students in the following three categories.

- To determine the student's ability to review, synthesize and apply fundamental concepts.
- To determine the creative and technical potential of the student to solve open-ended and challenging problems.
- To determine the student's technical communication skills.

The Ph.D. Qualifying Exam will typically be held in each regular semester to accommodate graduate students admitted in either the Fall or Spring. In the event of a student failing the Qualifying Exam, he or she will be given one further opportunity to pass the exam in the following semester. A second failure of the Qualifying Exam in a given specialty would lead to removal of the student from the Ph.D. program.

Admission to Candidacy Full-time students must complete the following requirements within two calendar years of enrolling in the Ph.D. program.

- Have a Thesis Committee appointment form on file in the Graduate Office;
- Complete all prerequisite and/or core courses in their chosen specialty
- Have passed the Ph.D. Qualifying Exam demonstrating adequate preparation for, and satisfactory ability to conduct doctoral research.

Upon completion of these requirements, students must complete an Admission to Candidacy form which can be obtained from http://inside.mines.edu/admiss/grad/info_current_students.htm

This form must be signed by the Thesis Committee, the Engineering Division Director, and filed with the Graduate Office. Successful Admission to Candidacy grants the student formal permission to begin doctoral research. Further details are available in the graduate bulletin.

Thesis Proposal After passing the Qualifying Examination, and no later than three years after entering the Ph.D. program, the full-time candidate is required to prepare a written Thesis Proposal and present it formally to the Thesis Committee. The proposal will describe the proposed research in sufficient detail for the committee to form an impression of its originality and feasibility. As soon as practicable thereafter, a meeting will be scheduled for the student to give an oral presentation of the proposal to the committee and other interested parties. At the oral presentation, the committee will have the opportunity to question the candidate on any aspect of the proposal ranging from in-depth technical issues to feasibility and timing of completion. The candidate will usually be informed at the end of the meeting whether the thesis proposal is acceptable to the committee. An acceptable thesis proposal is a necessary step in order for the candidate to proceed with his or her doctoral research. If the committee has concerns about the proposal, the candidate may be asked to modify the proposal and schedule a second meeting with the committee. A candidate will usually be allowed no more than two attempts to present a satisfactory thesis proposal to his or her Thesis Committee. Futher attempts can only be allowed with the consent of the Division Director and at the request of the Advisor.

Oral Thesis Defense At the conclusion of the M.S. (Thesis Option) and Ph.D. programs, the student will be required to present the thesis in hard copy to the Thesis Committee at least two weeks before the scheduled oral examination where the candidate will make a formal presentation and defense of her/his thesis research. For further details of the procedures followed at the thesis defense and the various possible outcomes, please refer to the Graduate Bulletin.

Deadlines and Checkout

Students should be aware of both department and Graduate School deadlines in order to schedule the defense in plenty of time to complete the process and graduate in any given semester. The Graduate School publishes a list of deadlines for graduation each semester in the Grad Student Handbook. See http://inside.mines.edu/admiss/grad/graduation_rqmts.htm#Dates

Students must complete all graduate degree requirements (including check out form and final submittal of your thesis) on or before the last day of registration of a semester to avoid having to register (and pay for) another semester.

All students expecting to graduate must submit a graduation application to the Graduate Office of Graduate Studies, and all graduating students must officially check out by completing and turning in a checkout card and paying a graduation fee. Note: your checkout card will not be signed until any borrowed books and borrowed lab or other materials have been returned. You need to get the initials of your Advisor.

Typical Timetables

Master of Science (Thesis option): (1.5- 2 years)

1st Semester: Begin course work;
Select an Advisor and research topic

2nd Semester: Appoint thesis committee (no later than 2nd semester)
Present proposed course of study and thesis topic
Continue course work and begin research.

2nd Year: Complete course work, research and thesis
Defend thesis

Master of Science (Non-Thesis option): (1-1.5 years)

1st Semester: Begin course work
Select an Advisor

2nd Semester: Continue and possibly complete course work

Doctor of Philosophy: (3- 5 years if starting with an M.S. degree and 4-5 years if starting with a B.S degree)

1st Semester: Begin course work
Select an Advisor and research topic
Possibly begin research

2nd Semester: Appoint thesis committee (no later than 2nd semester)
Present proposed course of study and thesis topic
Continue course work and research.

2nd Year: Pass Ph.D. Qualifying Exam (no later than 3rd semester).
Admission to Candidacy form (no later than two calendar years after enrolling)
Continue coursework and research.

3rd Year: Present Thesis Proposal to Committee (no more than 18 months after Qualifier)
Continue research.

4th Year: Complete research and thesis
Defend thesis

5th Year: May be necessary if transferred directly from B.S. to Ph.D. program.

Engineering Specialty Course Requirements

Civil Engineering Specialty (EGGN-CE)

There are two main emphasis areas within the Civil Engineering specialty in: (1) Geotechnical engineering, and (2) Structural engineering. Thesis research activities however, will regularly overlap with the other emphasis areas within the Division as listed in the Program Description above. The intent is to offer a highly flexible curriculum that will be attractive to candidates seeking Civil Engineering careers in either industry or academe. In addition to the Civil Engineering courses offered within the Engineering Division, technical electives will be available from other CSM departments such as Environmental Science and Engineering, Geological Engineering and Mining, as well as Electrical and Mechanical courses from within the Engineering Division.

M.S. Degree (Civil Specialty)

Must take at least three courses from the list of Civil Specialty Courses.	9 cr
EGGN504 Engineering (Civil) Seminar	1 cr
Technical Electives	
(Thesis option: Courses must be approved by the Thesis Committee)	14 cr
(Non-Thesis option: Courses must be approved by the Faculty Advisor)	20 cr
Non-thesis students may include up to 6 cr hours of Independent Study (EGGN 599)	
Thesis Research (Thesis Option)	6 cr
Total	*30 cr*

Ph.D. Degree (Civil Specialty)

Must take at least three courses from the list of Civil Specialty Courses	9 cr
EGGN504 Engineering Systems (Civil) Seminar	1 cr
Minor Program of Study	12 cr
Technical Electives	
Approved by the graduate committee	26 cr
Thesis Research	24 cr
Total	*72 cr*

Civil Specialty Core Courses

EGGN501	Advanced Engineering Measurements	4 cr
EGGN502	Interdisciplinary Modeling and Simulation	4 cr
EGGN531	Soil Dynamics	3 cr
EGGN532	Fracture and Fatigue	3 cr
EGGN533	Unsaturated Soil Mechanics	3 cr
EGGN534	Soil Behavior	3 cr
EGGN535	Introduction to Discrete Element Methods	3 cr
EGGN536	Hillslope Hydrology and Stability	3 cr
EGGN541	Advanced Structural Theory	3 cr
EGGN542	Finite Element Methods for Engineers	3 cr
EGGN545	Boundary Element Methods	3 cr
EGGN546	Advanced Engineering Vibration	3 cr
EGGN547	Timber and Masonry Design	3 cr
EGGN548	Advanced Soil Mechanics	3 cr
EGGN549	Advanced Design of Steel Structures	3 cr
EGGN550	Design of Reinforced Concrete Structures II	3 cr
EGGN560	Numerical Methods for Engineers	3 cr

Ph.D. Qualifying Exam (Civil Specialty)

Engineering (Civil Specialty) students wishing to enroll in the Ph.D. program will be required to pass a Qualifying Exam. Normally, Ph.D. students will take the Qualifying Exam in their first year, but it must be taken within three semesters of entering the program.

The exam will have two parts:

1. The Advisor will coordinate with the student's thesis committee to generate a written take-home exam based on materials covered in the students area of interest. This will typically involve two questions, and may cover material from the Engineering (Civil Specialty) core courses.
2. A written report (approx 10 pages) and oral presentation based on a topic that will be chosen by the graduate student's committee. The report will typically be a review paper on a research theme that will be related to the student's area of interest and likely thesis topic. The purpose of this requirement is to examine some of the attributes expected of a successful Ph.D. candidate. These include, but are not restricted to:

- The ability to perform a literature review through libraries and internet sites;
- The ability to distill information into a written report;
- The ability to produce a high quality written and oral presentation.

The research theme for the written report will be provided at the same time as the questions in part one above. All written material will be due one week later. As early as possible after that time, a one hour meeting will be scheduled for the student to make his/her oral presentation. After the oral presentation, the student will be questioned on the presentation and on any other issues relating to the written report and take home examination.

Electrical Engineering Specialty (EGGN-EE*)*
Within the Electrical Engineering specialty, there are two emphasis areas: (1) Sensing, Communications and Control, and (2) Energy Systems and Power Electronics. Students are encouraged to decide between emphasis areas before pursuing an advanced degree. Students are also encouraged to speak to members of the EE graduate faculty before registering for classes and to select an academic Advisor as soon as possible.

M.S. Degree (Electrical Specialty)

Select from the list of core Electrical Engineering Courses within one track	12 cr
EGGN504 Engineering (Electrical) Seminar	1 cr
Technical Electives (approved by thesis committee or Advisor for non-thesis option)	11 cr
EGGN705 Graduate Research Credit: Master of Science (thesis students)	
or	
Electrical Engineering Electives (taught by an approved professor in one of the EE specialty tracks)	6 cr
Total	*30 cr*

Ph.D. Degree (Electrical Specialty)

Select from the list of core Electrical Engineering Courses within one track	12 cr
EGGN504 Engineering (Electrical) Seminar	1 cr
Technical Electives (approved by thesis committee)	23 cr
Minor Program (approved by thesis committee)	12 cr
EGGN706 Graduate Research Credit: Doctor of Philosophy	24 cr
Total	*72 cr*

Electrical Specialty Core Courses
Energy Systems and Power Electronics Track

EGGN580	Power Quality	3 cr
EGGN582	Renewable Energy and Distributed Generation	3 cr
EGGN583	Advanced Electrical Machine Dynamics	3 cr
EGGN584	Power Distribution Systems Engineering	3 cr
EGGN545	Advanced High Power Electronics	3 cr
EGGN586	High Voltage AC and DC Transmission	3 cr
EGGN587	Intro to Power Systems Market Operations	3 cr

Sensing, Communications and Control Track

EGGN510	Image and Multidimensional Signal Processing	3 cr
EGGN513	Wireless Systems Design	3 cr
EGGN515	Mathematical Methods for Signals and Systems	3 cr
EGGN517	Advanced Control Theory and Design	3 cr
EGGN518	Robot Mechanics and Control	3 cr

Ph.D. Qualifying Exam (Electrical Specialty)

Doctoral students must pass a Qualifying Examination, which is intended to gauge the student's capability to pursue research in the Electrical Engineering specialty. The Qualifying Examination includes both written and oral sections. The written section is based on material from the Division's undergraduate Engineering degree with Electrical Specialty The oral part of the exam covers either two of the track courses (of the student's choice) in the Electrical Specialty, or a paper from the literature chosen by the student and the student's Advisor. The student's Advisor and two additional Electrical Specialty faculty members (typically from the student's thesis committee representing their track) administer the oral exam. Normally, Ph.D. students will take both parts of the Qualifying Examination in their first year, but they must both be taken within three semesters of entering the graduate program.

Written Exam Guidelines:

The written part is an open book, open notes, 3 hour exam, consisting of 12 problems, based principally on materials from CSM undergraduate courses in electrical engineering related to either the Energy Systems and Power Electronics Track or the Sensing, Communication, and Control Track.. Students must solve at least 8 out of the 12 problems in order to pass the exam. Students will be provided with detailed syllabi, textbook information, chapters and reading assignments from the textbooks, and sample tests/quizzes/examples from the relevant courses so that they can prepare for the written test. Specific topics covered on the exam are different for each track:

Energy Systems and Power Electronics: Students are specifically expected to have a solid foundation in the subject matter found in the following courses:

(a) 4 problems from: *Electric Circuits (EGGN 382)* and *Fundamentals of Electric Machinery (EGGN 389),* covering Basic Circuits, Magnetic Circuits and Fundamentals of Electric Machines and Transformers.
(b) 4 problems from: *Power Systems Analysis (EGGN 484)* covering Power Systems Analysis.
(c) 4 problems from: *Power Electronics (EGGN 485)* covering Power Electronics Fundamentals.

Sensing, Communication, and Control: Students are specifically expected to have a solid foundation in the subject matter found in the following courses:

(a) 4 problems from: *Information Systems (EGGN 388)* and *Introduction to Feedback Control Systems (EGGN 307),* covering basic digital signal processing and the fundamentals of classical control system analysis and design.
(b) 4 problems from: *Modern Control Design (EGGN 417)* covering the fundamentals of modern control system analysis and design.
(c) 4 problems from: *Analog & Digital Communication Systems (EGGN 483),* covering the basic concepts of communication systems.

Oral Exam Guidelines:
Although the Graduate Bulletin suggests two choices for the oral exam, it is highly recommended that students choose the research paper option. The student, in consultation with their Advisor, should select a topic related to his/her planned research. The student is expected to do some literature search, do all the reading, and make a technically informative presentation (typically 35-40 mins) for a broader audience. It is expected that the student will spend between one to two (calendar) months to prepare for the oral exam, which should serve to initiate their Ph.D. dissertation research.

*Based on **both the written test and oral presentation**, the Committee will determine whether the student has passed the Qualifying Exam. Official results will be communicated to the student by the end of the Spring semester. When appropriate and desirable, the Committee may ask the student for additional course work requirements and remedial action.*

Engineering Systems Specialty (EGGN-ES)
Graduate students who choose an interdisciplinary education in Engineering Systems may do so using the curriculum below.

M.S. Degree (Engineering Systems Specialty)

Required Core:		
EGGN501	Advanced Engineering Measurements	4 cr
EGGN502	Interdisciplinary Modeling and Simulation	4 cr
EGGN504	Engineering Systems (any Specialty) Seminar	1 cr
Technical Electives (Thesis Option: Courses must be approved by the graduate thesis committee)		15 cr
(Non-Thesis Option: Courses must be approved by the faculty Advisor)		21 cr
Thesis Research (Thesis Option)		6 cr
Total		*30 cr*

Ph.D. Degree (Engineering Systems Specialty)

Required Core:	
EGGN501 Advanced Engineering Measurements	4 cr
EGGN502 Interdisciplinary Modeling and Simulation	4 cr
EGGN504 Engineering Systems (Any Specialty) Seminar	1 cr
Minor Program of Study	12 cr
Technical Electives (must be approved by the graduate thesis committee)	27 cr
Thesis Research	24 cr
Total	*72 cr*

Engineering Systems Specialty Core Courses

The course requirements under the Engineering Systems Specialty are more flexible than those in the other specialty areas and an individualized curriculum can be designed by the graduate student in consultation with his/her Advisor.

Ph.D. Qualifying Exam (Engineering Systems Specialty)

Engineering (Engineering Systems) students wishing to enroll in the Ph.D. program will be required to pass a Qualifying Exam. Normally, Ph.D. students will take the Qualifying Exam in their first year, but it must be taken within three semesters of entering the program. The exam will have two parts:

1. The Advisor will coordinate with the Engineering Systems faculty to generate a written take-home exam based on materials covered in the students area of interest. This will typically involve two questions, and will cover material from the Engineering core courses (EGGN 501 and EGGN 502). The student will have two days to complete the exam.

2. A written report and oral presentation based on a topic that will be chosen by the graduate student's committee. The report will typically be a review paper on a research theme that will be related to the student's area of interest and likely thesis topic. The purpose of this requirement, is to examine some of the attributes expected of a successful Ph.D. candidate. These include, but are not restricted to:

- The ability to perform a literature review through libraries and internet sites;
- The ability to distill information into a written report;
- The ability to produce a high quality written and oral presentation.

The research theme for the written report will be provided at the student submits their take-home exam. All written material will be due two weeks later. As early as possible after that time, a two hour meeting will be scheduled for the student to make his/her oral presentation. After the oral presentation, the student will be questioned on the presentation and on any other issues relating to the written report and take home examination. The examination committee will consist of at least three faculty from the Engineering Systems group, not including the student's Advisor, but may be expanded to include other members of the student's thesis committee.

Mechanical Engineering Specialty (EGGN-ME)

Within the Mechanical Engineering specialty, there are three emphasis areas: (1) Mechanics of Materials, (2) Energy Conversion Systems and Thermal Sciences and (3) Biomedical Engineering. The specialty has strong ties to the chemical engineering, materials science and physics communities, and students will typically take courses in one or more of these areas after completing the core class requirements.

M.S. Degree (Mechanical Specialty)

Required Core:		
EGGN501	Advanced Engineering Measurements	4 cr
EGGN502	Interdisciplinary Modeling and Simulation	4 cr
EGGN504	Engineering Systems (Mechanical) Seminar	1 cr
From the list of Mechanical Engineering Courses		
(Thesis Option: Courses must be approved by the thesis committee)		9 cr
or		
(Non-Thesis Option: Courses must be approved by the faculty Advisor)		15 cr
Thesis Research (Thesis option)		6 cr
Technical Electives (thesis option: approved by thesis committee; non-thesis option: approved by faculty Advisor)		6 cr
Total		*30 cr*

Ph.D. Degree (Mechanical Specialty)

Required Core:		
EGGN501	Advanced Engineering Measurements	4 cr
EGGN502	Interdisciplinary Modeling and Simulation	4 cr
EGGN504	Engineering (Mechanical) Seminar	1 cr
Minor Program of Study		12 cr
From the list of Mechanical Engineering Courses		18 cr
Thesis Research		24 cr
Technical Electives (must be approved by the thesis committee)		9 cr
Total		*72 cr*

Mechanical Specialty Core Courses

EGGN503	Modern Engineering Design and Project Management	3 cr
EGGN514	Advanced Robot Control	4 cr
EGGN515	Mathematical Methods for Signals and Systems	3 cr
EGGN517	Theory and Design of Advanced Control Systems	3 cr
EGGN518	Robot Mechanics: Kinematics, Dynamics and Control	3 cr
EGGN520	Introduction To Biomedical Engineering	3 cr
EGGN521	Mechatronics	3 cr
EGGN525	Musculoskeletal Biomechanics	3 cr
EGGN527	Prosthetic and Implant Engineering	3 cr
EGGN528	Computational Biomechanics	3 cr
EGGN530	Biomedical Instrumentation	3 cr
EGGN532	Fatigue and Fracture	3 cr
EGGN535	Introduction to Discrete Element Methods	3 cr
EGGN540	Continuum Mechanics	3 cr
EGGN542	Finite Element Methods for Engineers	3 cr
EGGN544	Solid Mechanics of Nonlinear Materials	3 cr
EGGN545	Boundary Element Analysis	3 cr
EGGN546	Advanced Engineering Dynamics	3 cr
EGGN551	Mechanics of Incompressible Fluids	3 cr
EGGN552	Viscous Flow and Boundary Layers	3 cr
EGGN555	Kinetic Phenomena in Materials	3 cr
EGGN559	Mechanics of Particulate Media	3 cr
EGGN560	Numerical Methods for Engineers	3 cr
EGGN564	Physical Gas Dynamics	3 cr
EGGN566	Combustion	3 cr
EGGN567	Radiation Heat Transfer	3 cr
EGGN569	Fuel Cell Science and Technology	3 cr
EGGN572	Multiple Phase Flows and Transport Phenomena with Droplets and Particles	3 cr
EGGN573	Introduction to Computational Techniques for Fluid Dynamics and Transport Phenomena	3 cr
EGGN617	Intelligent Control	3 cr
EGGN619	Intelligent Structures	3 cr
EGGN642	Advanced Finite Element Analysis for Engineers	3 cr
EGGN659	Optical Measurements in Reacting and Nonreacting Flow Systems	4 cr

Ph.D. Qualifying Exam (Mechanical Specialty)

1. Qualifying Requirements

The requirements for the degree of doctor of philosophy include the passing of a qualifying examination, presentation of an acceptable thesis proposal and the passing of the final oral examination (thesis defense). The qualifying examination ascertains the student's knowledge and preparation for advanced research and scholarly work as well as aptitude for research and independent work. The Ph.D. degree from the Division of Engineering is a certification that the graduating student is well versed in the fundamentals of his or her chosen field and is capable of performing creative, independent research and of effectively communicating that work to a technically sophisticated audience. Consequently, the Ph.D. Qualifying Examination procedure has three objectives as stated on page 13.

The Program has one pre-requisite that must be satisfied prior to sitting for the Qualifying examination. The student must have successfully completed an appropriate course in advanced engineering mathematics. The mathematics requirement is meant to provide a strong foundational education. The mathematics requirement may be fulfilled by courses in calculus, partial and ordinary differential equations, linear algebra, Fourier methods, or statistics. The particular course should be at the graduate level. Selection of the mathematics course is subject to the approval of the Division of Engineering Graduate Curriculum Committee (example courses covering the above topics are MACS 348 and EGGN502). The mathematics course must be completed by the end of the semester preceding the Qualifying Examination, and the student is expected to have received a grade no lower than "B" in the course.

2. Areas of Concentration for the Qualifying Exam

The student must submit his/her Qualifying Examination Request Form to sit for the Qualifying Examination to the Engineering Graduate Student Administrator six weeks prior to the exam date. The selection of topic area must be done in consultation with the student's Advisor and must be approved by the Division of Engineering Graduate Committee and Director. The exam will be based on three areas of concentration (thermo-fluids, mechanics of materials, and biomechanics) listed below. Subject to the approval of the Division of Engineering Graduate Curriculum Committee and Director, the student may petition for an examination in an area outside the three areas listed.

The Qualifying Exam is designed to comprehensively address the material from both the student’s undergraduate and graduate course work. The selected topic area should constitute a coherent concentration in some field (e.g. thermo-fluids, mechanics of materials, and biomechanics). This component is not intended, however, to be a summary exam on the graduate course material but rather is an opportunity for the student to demonstrate an ability to synthesize the material from his or her courses and answer unfamiliar questions. The first year course of study and the course lists below should provide an adequate outline of the material needed to succeed in the “Qualifying Exam.”

The areas of concentration for the Qualifying examination are listed below. The examination is comprehensive and is not restricted to the content of graduate courses. The listed courses in the following the areas below serve as examples of the depth and extent of the expected material.

a. *Thermo-fluid Sciences*

Key topics: Differential and integral form of the conservation of mass, momentum and energy equations, hydrostatics, laminar and turbulent flow in pipes, boundary layers, dimensional analysis and dynamic similarity, fundamental laws of thermodynamics, thermodynamic cycles, chemical equilibrium, free and forced convection, steady and non-steady conduction, radiation of black and grey surfaces,…

Example courses from the Mines catalog: (EGGN351 (Fluid Mechanics I), EGGN473 (Fluid Mechanics II), EGGN371 (Thermodynamics I), EGGN403 (Thermodynamics II), EGGN471 (Heat transfer).

b. *Mechanics of Materials*

***Key topics:* Statics principles, FBDs, dynamics of particles and rigid bodies, equations of motion, work-energy and momentum methods, 1 DOF vibrational systems included damping and forcing functions, 2-D/3-D Hooke's law, combined states of stress generated by axial, bending and torsional loading, stress and strain transformations and principal values using Mohr's circle and matrix methods, ductile and brittle failure criteria, differential equations of equilibrium.**

Example courses from the Mines catalog: (EGGN315 (Dynamics), EGGN320 (Mechanics of Materials), EGGN422 (Advanced Mechanics of Materials).

c. *Biomechanics*

Key topics: Statics principles; free body diagrams; dynamics of particles and rigid bodies; development of the equations of motion for a two degree-of-freedom system; Hooke's Law in 3-dimensions; combined states of stress with axial, bending and torsional loading; principal stresses; development and solution of finite element equations for a 1-dimensional truss problem; fundamentals of the finite element method including mesh convergence and characteristics of first and second order elements; gross skeletal and basic muscular anatomy; anatomy of the major joints and connective tissues.

Example courses from the Mines catalog: Dynamics (EGGN315), Mechanics of Materials (EGGN320), Computer Aided Engineering (EGGN413), Musculoskeletal Biomechanics (EGGN425), Computational Biomechanics (EGGN428).

The Qualifying Examination will be administered by a committee consisting of a total of five faculty members (including the thesis Advisor), and is normally chaired by the student's Advisor. The student's Advisor can not participate as an examiner, but is a voting member of the Examination Committee. At least three of the faculty members must be from the Program in Engineering, and entire Examination Committee will be selected by the Division of Engineering Graduate Curriculum Committee in consultation with the Division Director.

3. Format for the Qualifying Exam

The appointed Qualifying Examination faculty committee for a given area of concentration will prepare and pose all questions for the Qualifying Examination. Following the examination, the examiners and faculty Advisor will convene to decide whether or not the student has successfully completed the "Qualifying Exam" component. Official results will be communicated to the student in a timely manner. When appropriate and desirable, the Examination Committee may ask the student for additional course work requirements and remedial action.

The Qualifying Examination consists of a written and an oral part:

a. *Written Part*: The written part consists of a set of questions for the selected area of concentration. These questions will be prepared by the selected faculty Examination Committee. The format of this exam will be open book and have a maximum duration of four hours.

b. *Oral Part*: The oral examination will have a maximum duration of two and half hours and will consist of follow-up questions related to the questions posed during the "Written Part." During this oral examination, to take place no later than two weeks following the Written Part, the candidate will be interviewed by the faculty Examination Committee to explore the student's knowledge of engineering mathematics and the specialty areas. Each examiner will be allocated a maximum continuous 30 minute period for questions.

APPENDIX 1

Summary of requirements for the M.S. Degree

Master of Science in Engineering (Thesis option)				
	Civil	**Electrical**	**Engineering Systems**	**Mechanical**
Core	*EGGN 504 plus three courses from the CE list. 10 cr*	*EGGN 504 plus four courses from one of two EE tracks 13 cr*	*EGGN 501, 502, 504 9 cr*	*EGGN 501, 502, 504 9 cr*
Technical Electives and other courses with Advisor approval	*Choose 14 cr from CE list and/or other courses.*	*Choose 11 cr from the EE list.*	*Choose 15cr*	*Choose 9 cr from ME list plus 6 cr of other technical courses.*
Thesis research	*6 cr*	*6 cr*	*6 cr*	*6 cr*

Master of Science in Engineering (Non-Thesis option)				
	Civil	**Electrical**	**Engineering Systems**	**Mechanical**
Core	*EGGN 504 plus three courses from the CE list. 10 cr*	*EGGN 504 plus four courses from one of two EE tracks 13 cr*	*EGGN 501, 502, 504 9 cr*	*EGGN 501, 502, 504 9 cr*
Technical Electives and other courses with Advisor approval	*Choose 20 cr from CE list and/or other courses.*	*Choose 17 cr from the EE list.*	*Choose 21cr*	*Choose 15 cr from ME list plus 6 cr of other technical courses.*

Summary of requirements for the Ph.D. Degree

Doctor of Philosophy in Engineering				
	Civil	**Electrical**	**Engineering Systems**	**Mechanical**
Core	*EGGN 504 and choose from CE list 10 cr*	*EGGN 504 and four courses from one of two tracks 13 cr*	*EGGN 501, 502, 504 9 cr*	*EGGN 501, 502, 504 9 cr*
Minor	*12 cr*	*12 cr*	*12 cr*	*12 cr*
Technical Electives and other courses with Advisor approval	*Choose 26 cr from CE list and/or other courses.*	*Choose 23 cr technical electives.*	*Choose 27 cr technical electives*	*Choose 18 cr from ME list plus 9 cr of other technical courses.*
Thesis research	*24 cr*	*24 cr*	*24 cr*	*24 cr*

APPENDIX 2
Typical Programs of Study

* = used as part of the core

Civil Specialty (MS, non-thesis)

Fall (14 credits)
EGGN504 – Civil Engineering Seminar (1)
EGGN599 – Independent Study (Hydraulic Properties of Soils) (3)
ESGN 536 – Hillslope Hydrology and Stability (3)
GEGN 583– Math Modeling Groundwater Systems (3)
GPGN 574– Groundwater Geophysics (4)

Summer (3 credits)
EGGN560 – Numerical Methods for Engineers (3)

Spring (15 credits)
EGGN531 – Soil Dynamics* (3)
EGGN533 – Unsaturated Soil Mechanics* (3)
EGGN542 – Finite Element Methods* (3)
MNGN 545 – Rock Slope Engineering (3)
CE 5820 – Transfer Graduate Credit "Advanced Geotechnical Laboratory" (3)

Civil Specialty (MS, Thesis)

Spring (10 credits)
EGGN504 – Civil Engineering Seminar (1)
EGGN531 – Soil Dynamics* (3)
EGGN542 – Finite Element Methods for Engineers (3)
EGGN549 – Advanced Design of Steel Structures (3)

Summer (3 credits)
EGGN705 – Graduate Research Credit – Masters (3)

Fall (10 credits)
EGGN502 – Interdisciplinary Modeling & Simulation (4)
EGGN534 – Soil Behavior* (3)
EGGN548 – Advanced Soil Mechanics* (3)

Spring (9 credits)
EGGN498 – Engineering Design Optimization (3)
MATH550 – Numerical Solutions to Partial Differential Equations (3)
EGGN705 – Graduate Research Credit – Masters (3)

Civil Specialty (Ph.D.)

Fall (7 credits)
EGGN502–Interdisciplinary Modeling & Simulation (4)
EGGN548–Adv Soil Mechanics* (3)
EGGN388–Information Systems Science (3) (remedial – not used towards degree requirements)

Spring (10 credits)
EGGN501–Advanced Engineering Measurements (4)
EGGN598–Advanced Foundations* (3)
GEGN573–Geological Engineering Site Investigation (3)

Fall (7 credits)
EGGN504–Engineering Graduate Colloquium (1)
EGGN598–Soil Dynamics & Foundation Vib* (3)
EGGN599–Independent Study (3)

Spring (6 credits)
EGGN598–Intro Stochastic Processes (3)
GPGN605–Inversion Theory (3) (Minor)

Fall (9 credits)
GPGN404– Digital Analysis (3) (Minor)
GPGN552– Intro to Seismology (3) (Minor)
MNGN508– Advanced Rock Mechanics (3)

Spring (9 credits)
EGGN542– Finite Element Methods (3)
GEGN672–Advanced Geotechnics (3)
GPGN530–Applied Geophysics (3) (Minor)

Remaining Semesters
EGGN706 – Graduate Research Credit: Doctor of Philosophy (3) (as needed to fulfill 24-credit requirement)

Electrical Specialty (MS, non-thesis)
(Sensing, Communications, and Control)

Fall (16 credits)[1]
EGGN504 – Electrical SCC Seminar (1)
EGGN510 – Image and Multidimensional Signal Processing (3)
EGGN515 – Mathematical Methods for Signals and Systems (3)
EGGN516 – RF and Microwave Engineering (3)
EGGN518 – Robot Mechanics and Control (3)
EGGN582 – Renewable Energy and Distributed Generation (3)

Spring (15 credits)
EGGN512 – Computer Vision (3)
EGGN513 – Wireless System Design (3)
EGGN517 – Advanced Control Theory and Design (3)
EGGN521 – Mechatronics (3)
EGGN589 – Design and Control of Wind Energy Systems (3)

Electrical Specialty (MS, thesis)
(Energy Systems and Power Electronics)

Fall (10 credits)
EGGN504 – Electrical ESPE Seminar (1)
EGGN582 – Renewable Energy and Distributed Generation (3)
EGGN584 – Power Distribution Systems Engineering (3)
EGGN705 – Graduate Research Credit: Master of Science (3)

Spring (12 credits)
EGGN580 – Electric Power Quality (3)
EGGN581 – Modern Adjustable Speed Electric Drives (3)
EGGN583 – Advanced Electrical Machine Dynamics (3)
EGGN585 – Advanced High Power Electronics (3)

Fall (9 credits)
EGGN586 – High Voltage AC and DC Power Transmission (3)
EGGN587 – Introduction to Power Systems Market Operations (3)
EGGN705 – Graduate Research Credit: Master of Science (3)

[1] Full time tuition is assessed for 9-15 credits, so taking an additional credit will lead to an increase in tuition.

Electrical Specialty (Ph.D.)
(Sensing, Communications, and Control)

Fall (13 credits)
EGGN604 – Electrical SCC Seminar (1)
EGGN510 – Image and Multidimensional Signal Processing (3)
EGGN515 – Mathematical Methods for Signals and Systems (3)
EGGN516 – RF and Microwave Engineering (3)
EGGN582 – Renewable Energy and Distributed Generation (3)

Spring (12 credits)
EGGN512 – Computer Vision (3)
EGGN513 – Wireless System Design (3)
EGGN517 – Advanced Control Theory and Design (3)
EGGN520 – Introduction to Biomedical Engineering (3) (Minor)

Fall (12 credits)
EGGN518 – Robot Mechanics and Control (3)
EGGN525 – Musculoskeletal Biomechanics (3) (Minor)
EGGN530 – Biomedical Instrumentation (3) (Minor)
EGGN587 – Introduction to Power Systems Market Operations (3)

Spring (12 credits)
EGGN519 – Estimation Theory and Kalman Filtering (3)
EGGN521 – Mechatronics (3)
EGGN528 – Computational Biomechanics (3) (Minor)
EGGN589 – Design and Control of Wind Energy Systems (3)

Remaining Semesters
EGGN706 – Graduate Research Credit: Doctor of Philosophy (3) (as needed to fulfill 24-credit requirement)

Mechanical Specialty (M.S, non-thesis)
(Thermo-Fluids)

Fall (15 credits)
EGGN471 – Heat transfer (3)
EGGN501– Advanced Engineering Measurements (4)
EGGN502 –Interdisciplinary Modeling and Simulation (4)
EGGN504 – Engineering (Mechanical) Seminar (1)
EGGN566 – Combustion (3)

Spring (15 credits)
EGGN473 – Fluid Mechanics II (3)
EGGN552 – Viscous Flow and Boundary Layers (3)
EGGN569 – Fuel Cell Science and Technology (3)
EGGN582 – Renewable Energy and Distributed Generation (3)
EGGN589 – Design and Control of Wind Energy Systems (3)

Mechanical Specialty (Ph.D.)
(Thermo-Fluids)

Fall (14 credits)
EGGN501– Advanced Engineering Measurements (4)
EGGN502 – Interdisciplinary Modeling and Simulation (4)
EGGN504 – Engineering (Mechanical) Seminar (1)
EGGN566 – Combustion (3)

Spring (12 credits)
EGGN473 – Fluid Mechanics II (3)
EGGN520 – Introduction to Biomedical Engineering (3) (Minor)
EGGN552 – Viscous Flow and Boundary Layers (3)
MATH510 – Ordinary Differential Equations and Dynamical Systems (3)

Fall (12 credits)
ChEN507– Applied Mathematics in Chemical Engineering (3)
EGGN403 – Thermodynamics II (3)
EGGN525 – Musculoskeletal Biomechanics (3) (Minor)
EGGN530 – Biomedical Instrumentation (3) (Minor)

Spring (12 credits)
EGGN528 – Computational Biomechanics (3) (Minor)
EGGN569 – Fuel Cell Science and Technology (3)
EGGN573 – Introduction to Computational Techniques for Fluid Mechanics and Transport Phenomena (3)
ChEN516 – Transport Phenomena (3)

Remaining Semesters
EGGN706 – Graduate Research Credit: Doctor of Philosophy (3) (as needed to fulfill 24-credit requirement)