Mineral Engineering

Professor Aimone-Martin, Chávez
Associate Professors Fakhimi, N. Mojtabai (Chair of the Department)
Adjunct Faculty: Barker, Gundiler, Kozushko, Kuhn, McLemore, C. Mojtabai, Walder
Emeritus Professors Oravecz, Wolski

Degrees Offered: B.S. in Mineral Engineering; B.S. in Mineral Engineering with Emphasis in Explosives Engineering; M.S. in Mineral Engineering

Department Mission Statement

- To provide the students with an education in the fundamentals of engineering that will allow immediate entry into industry or research work while providing a good opportunity for continued professional growth.
- To maintain a team of faculty who are committed to providing high quality of teaching and research.
- To prepare the students for the challenges of establishing a successful diversified career in the rapidly changing professional environment.

Program Educational Objectives

1) To inspire, as a primary goal, creativity in thinking and skills in problem solving to assist industry in meeting daily challenges
2) To develop a responsible professional with a sense of social awareness
3) To promote excellence in independent and open-ended engineering problem solving, oral and written presentation skills
4) To provide proficiency in basic science and engineering skills
5) To provide real-world experiences through summer jobs and field trips to operations in New Mexico as well as other states and countries for immediate entry into industry
6) Program graduates will achieve a measurable advancement in professional duties and salaries and be capable of demonstrating continued professional growth within the first seven years after graduating

Mineral engineering is concerned with the exploration for and development of minerals and earth materials in the most efficient manner while protecting the environment. The undergraduate program is oriented toward developing the student's understanding of, and skill in, engineering design. Proficiency in project management and leadership are encouraged through coursework and projects that emphasize professional-quality written and oral communication skills. The objective of the program is to provide the student with an education in the fundamentals of engineering that will allow immediate entry into industry or research work while providing a good opportunity for continued professional growth. Emphasis is placed on developing a responsible professional with a sense of social awareness.

The curriculum includes basic engineering principles that provide the foundation for applied engineering design concepts. The program provides a concentrated study in mechanics, mineral evaluation and economics, ground and environmental control, environmental issues, and project management. Engineering design is introduced in courses covering surface and underground mining, ventilation, mineral processing, equipment selection, drilling and blasting, soil and rock mechanics, hydraulic structures, and geomechanics. Instruction in the environmental aspects of minerals development and production include mine permitting and reclamation, extending to the legal issues and concerns in natural resources development.

A large-scale design project is undertaken in the senior year. This project integrates engineering principles and design in one of three areas: economic evaluation and exploration for mineral properties; design and planning of a mining project; or the planning and implementation of geotechnical construction projects, such as landfills, tailings impoundments, earth dams, and structures.

The department has modern well-equipped laboratories for instruction and research in soil and rock mechanics, ventilation, blast vibrations, mineral evaluation, and computer applications. The department also maintains its own experimental underground mining facility to allow students valuable hands-on experience in solving mineral engineering problems. Students are provided the opportunity to work on a wide range of applied research projects within both the department and the Institute. Students are encouraged to obtain summer jobs available in mines across the Southwest, providing excellent industrial experience.

Undergraduate Program

Bachelor of Science in Mineral Engineering

Minimum Credit Hours Required—132
In addition to the General Degree Requirements (page 48), the following courses are required:

- MATH 231 (4), 335 (3)
- ES 110 (2), 111 (3), 201 (3), 216 (3), 302 (3), 332 (3)
- ES 303 or 347 (3)
- GEOL 101 & 101L (4), 211 (4), 353 (3)
- ME 101 (1), 220 (3), 320 (2), 340 (3), 360 (3), 380 (6), 410 (3), 419 (2), 420 (4), 435 (2), 440 (2), 442 (4), 462 (3), 470 (1), 471 (2)

All engineering majors are required to take the Fundamentals in Engineering (FE) exam as a requirement for graduation.

Sample Curriculum for the Bachelor of Science in Mineral Engineering

Semester 1

1	ME 101 (intro)
4	GEOL 101 & 101L (principles)
4	MATH 131 (calculus)
4	CHEM 121 & 121L (general)
3	ENGL 111 (college English)
2	ES 110 (intro)
18	Total credit hours

Semester 2

3	ES 111 (intro)
4	MATH 132 (calculus)
4	CHEM 122 & 122L (general)
3	ENGL 112 (college English)
3	Social Science
17	Total credit hours

Semester 3

5	PHYS 121 & 121L or 131 & 131L (general)
4	MATH 231 (calculus)
4	GEOL 211 (mineralogy)
3	Humanities
16	Total credit hours

Semester 4

3	ME 220 (surveying and map preparation)
2	ME 320 (economic analysis)
5	PHYS 122 & 122L or 132 &132L (general)
3	MATH 335 (applied analysis)
3	ES 201 (statics)
16	Total credit hours

Semester 5

3	ME 340 (geostatistics and mineral evaluation)
3	ME 360 (exploration and field mapping)
3	ES 302 (strength of materials
3	ES 216 (fluids)
3	ENGL 341 (technical writing)
3	Social Science
18	Total credit hours

Semester 6

6	ME 380 (mine systems)
4	ME 420 (soil and rock mechanics)
3	ME 462 (mineral deposits)
3	GEOL 353 (structural)
16	Total credit hours

Semester 7

3	ME 410 (environmental issues)
2	ME 440 (mine ventilation)
4	ME 442 (applied geomechanics)
1	ME 470 (senior design I)
3	ES 347 (thermodynamics) or ES 303 (dynamics)
3	Humanities/Social Science
16	Total credit hours

Semester 8

2	ME 419 (mineral and natural resource law)
2	ME 435 (mineral processing)
2	ME 471 (senior design II)
3	ES 332 (electrical engineering)
3	Humanities
3	Social Science
15	Total credit hours

Bachelor of Science in Mineral Engineering with Emphasis in Explosives Engineering

Minimum credit hours required—140
In addition to the General Degree Requirements (page 48), the following courses are required:

- MATH 231 (4), 335 (3)
- ES 110 (2), 111 (3), 216 (3), 301 (3), 302 (3), 303 (3), 332 (3)
- GEOL 101 & 101L (4), 211 (4), 353 (3)
- ME 101 (1), 220 (3), 320 (2), 340 (3), 360 (3), 380 (6), 410 (3), 419 (2), 420 (4), 434 (3), 435 (2), 440 (2), 442 (4), 470 (1), 471 (2)
- ChE 475 (3) or ED 441 (3) or ME 545 (3)

Students are strongly encouraged to do their senior design projects in the area of Explosives Engineering or related projects.

Minor in Mineral Engineering

Minimum credit hours required—19
Chosen from the following courses:

- ME 220 (2), ME 320 (2) or ES 316 (3), ME 340 (3), ME 360 (3), ME 380 (6), ME 410 (3), 419 (2), ME 420 (4), ME 434 (3), ME 435 (2), ME 440 (2), ME 442 (4), ME 462 (3)

Students may substitute other courses with the approval of the department. Students are also responsible for prerequisites.

Graduate Program

Master of Science in Mineral Engineering

Admission to the Master of Science in Mineral Engineering program requires competence in mathematics, chemistry, physics, and engineering science comparable to the bachelor of science degree in mineral engineering. Applicants without an engineering degree may apply for the graduate program in Mineral Engineering. However, the student will be required to take ES 201, ES 302, and ME 420. Any other deficiencies may have to be covered as required the the advisory committee.

The student's course of study must be approved by the student's advisory committee and fulfill the general requirements for the master's degree.

Of the 30 hours required for the M.S. degree, a minimum of 12 credit hours must be in approved Mineral Engineering courses. All graduate students must complete at least one credit of ME 572 (graduate seminar). Under special consideration, a student may petition the advisory committee with approval of the Department Chair to pursue a Master of Science degree with Independent Study (three hours of ME 590). A formal paper will be submitted with an oral presentation to the advisory committee.

The student may select one area of specialization as outlined below; within each specialization, recommended courses are provided.

- Mineral Exploration—At least 12 credits selected from ME 511, ME 521, ME 522, ME 523, ME 551, ME 562, ME 563. Other courses can be substituted with the approval of the research advisor and committee.
- Geotechnical Engineering—At least 12 credits selected from ME 512, ME 515 or EM 515, ME 517 or EM 517, ME 520, ME 525, ME 531, ME 532, ME 535, ME 537, ME 540, ME 561. Other courses can be substituted with the approval of the research advisor and committee.
- Explosives Engineering—At least 12 credits selected from ME 512, ME 515 or EM 515, ME 517 or EM 517, ME 520, ME 534, ME 545, ME 548, ME 549 or EM549, ME 550, ME 552, ME 553 or EM553, ME 556, ME 570, CHEM 540. Other courses can be substituted with the approval of the research advisor and committee.

Mineral Engineering Courses:

ME 101, Introduction to Mineral Engineering, 1 cr, 1 cl hr
The fundamentals of geology and mineral resource exploration and development applied to engineering. The role of the mineral engineer in mining, exploration, and geotechnical engineering. Field trips to mining and construction operations as well as guest speakers from industry, government, and research.

ME 215, Health and Safety, 2 cr, 2 cl hrs
Offered on demand
The roles of health and safety in the construction, operation, and maintenance of extractive mineral facilities. Federal and state health and safety codes. Laboratory and field work.

ME 220, Surveying and Map Preparation, 3 cr, 2 cl hrs, 3 lab hrs
Prerequisites: MATH 131, ES 111
Surveying instruments and measurement techniques. Data acquisition by means of advanced surveying methods for map production. Layout design and measurements. Correlations of surface and underground surveys.

ME 315, Mining Lab, 2 cr, 1 cl hr, 2 lab hrs
Prerequisite: Consent of instructor
Offered on demand
An introduction and hands-on experience in underground mine work: health and safety, support placement, mucking, dewatering, mapping and surveying. All classes are held at the department's experimental mine (Waldo mine).

ME 320, Economic Analysis, 2 cr, 2 cl hrs
Prerequisite: ES 111
Economic principles applied to decision-making problems in mineral engineering. Compound interest, depreciation, present worth and rate of return pertinent to project evaluation.

ME 340, Geostatistics and Mineral Evaluation, 3 cr, 2 cl hr, 2 lab hrs
Prerequisites: ES 111; ME 320
Introduction to statistics. Obtaining, evaluating, and presenting mineral resource information. Ore reserves estimation using geometric weighting techniques and geostatistical methods. The use of computers is emphasized.

ME 360, Exploration and Field Mapping, 3 cr, 2 cl hrs, 3 lab hrs
Prerequisites: GEOL 211; ME 220
Corequisite: ENGL 341
The acquisition and presentation of field geological data applied to engineering site characterization and mineral exploration. Data presentation. Elements of exploration techniques including field applied mineralogy, geophysics, structural geology, geochemistry, drilling and sampling, and mapping. Laboratory reports and oral presentations.

ME 380, Mine Systems, 6 cr, 4 cl hrs, 6 lab hrs
Prerequisite: ME 340, ME 320, or ES 316
Surface and underground mining methods and design; drilling and blasting design; materials handling and equipment selection. Concepts of mine plant design. Emphasis on computer applications.

ME 409, Design of Structures, 3 cr, 2 cl hrs, 3 lab hrs
Prerequisite: ES 302
Offered on demand
Reinforced concrete; concrete design, beams, slabs, retaining walls, columns, and footings. Grouting and shotcreting. Structural steel design: tension members, beams, columns, bolted and welded connections, frames, and trusses. Rock bolting. Rigging. PC applications. Student presentations on selected topics. A design project is required.

ME 410, Environmental Issues, 3 cr, 3 cl hrs
Prerequisites: ME 380; ES 216
Corerequisite: ME 442
Mine waste characteristics; regulations affecting mine operations; site selection, design and stability analysis of tailings impoundments. Water quality issues and control in mining. Mine waste management. Mine permitting requirements and reclamation. Design projects.

ME 419, Legal Aspects of Mineral Engineering, 2 cr, 2 cl hr
Prerequisite: Senior standing
A comprehensive study of laws pertaining to the exploration, planning, and development for resource extraction including minerals and water. Mineral and water rights issues will be presented and debated. A case study paper will be presented.

ME 420, Soil and Rock Mechanics, 4 cr, 3 cl hrs, 3 lab hrs
Prerequisite: ES 302
Corequisite: GEOL 353
Stress-strain properties and engineering classification of soils. Compaction, consolidation and seepage analysis and design. Mechanical properties of rock and rock masses. Classification of rock masses for engineering purposes. Principles of design and support of excavations.

ME 421, Applied Economic Geology , 3 cr, 2 cl hrs, 3 lab hrs
Prerequisite: GEOL 353
Offered on demand
Lithologic and lithochemical characterization of metalliferous ore deposits through the use of ore and alteration sample suites collected from various classes of deposits. Identification of hand specimen mineralogy; thin section and polished section analyses to establish paragenesis of both ore and gangue mineralization. Theoretical considerations ascertained by use of appropriate phase diagrams. Interpretation of wallrock alteration and characteristics of mineral paragenesis for major ore deposit types. Design and implementation of mineral exploration using field and laboratory observations.

ME 427, Site Investigation, 3 cr, 2 cl hrs, 3 lab hrs
Prerequisite: ME 420
Offered on demand
Design of engineering site investigation for project planning and construction; acquisition, presentation, and interpretation of geologic field data for engineering design. Design concepts for rock and soft ground tunneling, rock slopes, tailings dams, landslides, ground subsidence, collapsible and swelling soils. Computer-aided data reduction and design.

ME 434, Drilling and Blasting Engineering, 3 cr, 3 cl hrs
Prerequisites: ES 302
Offered on demand
Introductory course in the application of explosives to rock fragmentation; theory of detonation and mechanisms of rock failure, dynamics, and propagation. The effects of rock properties on breakage. Blasting systems and production blasting techniques used in both surface and underground designs; environmental considerations and regulations. Principles of blasthole drilling and drill performance. Drilling and blasting economics.

ME 435, Mineral Processing, 2 cr, 1 cl hr, 2 lab hrs
Prerequisite: ME 380; ES 216 and 347
Theory and practice of concentration of ores and industrial minerals. Crushing, grinding, sizing, gravity separation, flotation, leaching, solid-liquid separations.

ME 440, Mine Ventilation, 2 cr, 2 cl hrs
Prerequisite: ME 380
Control of underground environmental problems; dusts, gases, temperature, and humidity. Analysis of natural and mechanical ventilation systems and equipment. Measurement techniques

ME 442, Applied Geomechanics, 4 cr, 3 cl hrs, 3 lab hrs
Prerequisite: ME 420
Analysis and design of structures and excavations in geological media on surface and underground. Support and reinforcement design. Geological hazards and remedial measures. Design projects.

ME 462, Mineral Deposits, 3 cr, 2 cl hrs, 2 lab hrs
Prerequisites: GEOL 211
Ore formation processes and ore mineralogy; geologic and geochemical characterization of ore deposits using hand specimen, petrographic, and field mapping techniques. Visits to prospects and operating mines to observe variations in ore deposit characteristics to document geologic and geochemical parameters used to describe ore-forming systems. (Same as GEOL 462)

ME 470, Senior Design I, 1 cr, 1 cl hr
Prerequisite: Senior standing and consent of instructor
Initiation of senior design project including written and oral project proposal; estimation of project design requirements and costing. Preliminary data acquisition and evaluation. Design topics are selected from mineral exploration, mine or geotechnical engineering.

ME 471, Senior Design II, 2 cr, 2 cl hrs
Prerequisite: ME 470 passed with a grade of "C" or better.
Continuation of design projects initiated in ME 470; implementation and evaluation of design details including cost analysis. Preparation of final project report with written and oral professional-style presentations.

ME 491, Directed Study, 1–4 cr as arranged
Special projects or topics in mining or geological engineering.

ME 500, Directed Research, cr to be arranged
This course may not be used to fulfill graduate degree requirements.
Research under the guidance of a faculty member.

ME 505, Graduate Seminar, 1 cr

ME 511, Mineral Economics, 3 cr, 3 cl hrs
Prerequisite: ES 316 recommended, or consent of instructor
Domestic and international mineral statistics, marketing, trade, conservation, and taxation. Energy economics. Labor economics. Economic calculations for feasibility studies on mineral properties. Participants prepare and present professional-style reports on international mineral development.

ME 512, Advanced Rock Mechanics, 3 cr, 2 cl hrs, 3 lab hrs
Prerequisite: ME 420 or consent of instructor
Three-dimensional continuum mechanics. Basic theoretical solutions of idealized excavations. Numerical methods applied to design and stability analysis of excavations. Selected topics.

ME 515, Theory of Elasticity, 3 cr, 3 cl hrs
Prerequisite: Graduate standing or consent of the instructor
An introduction to tensor analysis, analysis of stress, balance laws, infinitesimal and finite theories of motion, strain and rotation tensors, compatibility equations, constitutive equations, materials symmetry, uniqueness of the solution, solution of two-dimensional elasticity problems. Airy stress function, application of complex variable technique in elasticity, three-dimensional elasticity problems, energy methods, bending theory of plates. (Same as EM 515)

ME 517, Advanced Finite Element Method, 3 cr, 3 cl hrs
Prerequisite: Graduate standing or consent of the instructor
An introduction to the numerical analysis calculus of variation, weak form of a differential equation, weighted residual techniques, solution of one-dimensional problems by the finite element method, bending problems, Lgrange and Hermite interpolation functions, isoparametric elements, numerical integration, two-dimensional problems, solution of Poisson and Laplace equations, triangular and quadrilateral elements, elasticity problems, theorem of minimum potential energy stiffness matrix, examples. (Same as EM 517)

ME 520, Fracture Mechanics, 3 cr, 3 cl hrs
Prerequisite: Graduate standing or consent of the instructor
An introduction to the theory of elasticity, singular stress fields, Westergaard method, complex variable technique, stress intensity factor, fracture energy, numerical and experimental methods in determination of stress intensity factor, fracture toughness, J-integral Elasto-plastic fracture. (Same as EM 520)

ME 521, Advanced Minerals Exploration, 3 cr, 3 cl hrs
Prerequisites: ME 360 or consent of instructor
Practical application of geologic, geochemical, and geophysical exploration techniques to ore search. Remote sensing technology and integration into grassroots exploration programs. Recent developments in geophysical and geochemical prospecting. Case histories. Field application of mineral exploration techniques.

ME 522, Advanced Mineral Exploration Field Mapping, 3 cr, 2 cl hrs, 2 lab hrs
Prerequisites: ME 360 or consent of instructor
Detailed mapping of mineral deposits and prospects in collaboration with professional exploration geologists and engineers with application to minerals exploration. Design and implementation of orientation surveys. Field studies will include geochemical and geological laboratory analysis. Written reports and oral presentation of projects will be reviewed by professionals.

ME 523, Ore Petrography, 3 cr, 3 cl hrs
Prerequisite: GEOL 211 or consent of instructor
Identification and description of opaque and semi-opaque minerals using polished sections complemented by reflected-light petrographic techniques. Sampling techniques for exploration, mining, and environmental remediation purposes. Preparation of polished samples from rock, rock chip, ore concentrate, and tailings sample types. Heavy liquid separation techniques for concentration of heavy minerals and quantitative mineral analyses.

ME 525, Rock and Soil Plasticity, 3 cr, 3 cl hrs
Prerequisite: Graduate standing or consent of the instructor
Introduction to the theory of elasticity, Tresca, Von Misses and Mohr-Coulomb failure criteria, flow rule, hardening, softening and perfect plasticity, method of characteristics in solving plasticity problems, kinematics and velocity discontinuity, plastic limit analysis, upper- and lower-bound theorems, examples in soil and rock mechanics.

ME 531, Advanced Foundation Design and Analysis, 3 cr, 3 cl hrs
Prerequisite: ME 420 or consent of instructor
Advanced foundation design. Design of construction projects including but not limited to highways, airports, landfills, and slopes. Application of geosynthetics in design. Causes and remediation of structural cracking and foundation failures. Legal aspects. Case studies.

ME 532, Advanced Soil Mechanics, 3 cr, 2 cl hrs, 3 lab hrs
Prerequisite: ME 420 or consent of instructor
Advanced laboratory testing of soils and their behavior with special attention to problem soils. Lab testing will include but not be limited to direct shear, compaction, swell consolidation, and seepage analysis. Special projects may be selected.

ME 534, Advanced Drilling and Blasting Engineering, 3 cr, 3 cl hrs
Prerequisite: Graduate standing or consent of the instructor
Application of explosives to rock fragmentation; theory of detonation and mechanisms of rock failure, dynamics, and propagation. The effects of rock properties on breakage. Blasting systems and production blasting techniques used in both surface and underground designs, environmental considerations and regulations. Principles of blasthole drilling and drill performance. Drilling and blasting economics.

ME 535, Stability of Rock Slopes, 3 cr, 2 cl hrs, 3 lab hrs
Prerequisite: ME 420 or consent of instructor
Basic mechanics of slope failure. Field exploration and presentation of geological data. Shear strength of rock and rock discontinuities. Groundwater pressure and flow. Plane, wedge, circular, and toppling failure. Improvement of slope stability by drainage and support. Monitoring of slope displacements.

ME 537, Design and Construction of Underground Openings, 3 cr, 3 cl hrs
Prerequisite: ME 420 or consent of instructor
Rock mass classification systems. Empirical design and support selections, stand-up times, block stability, and structural analysis. Elasto-plastic strain around openings. Ground reaction and response. Rock bolting and rock-support interaction analysis.

ME 540, Numerical Methods in Geotechnical Engineering, 3 cr, 3 cl hrs
Introduction to matrix, finite difference, and finite element methods with application to various problems in geomechanics, including the design of foundations, steady state seepage, slope stability, and underground excavations.

ME 545, Vibration Analysis and Control, 3 cr, 3 cl hrs
Prerequisite: ME 434 or consent of instructor
Characteristics and analysis of vibrations from mining and construction blasting, heavy equipment and transient loads. Prediction of ground motions, air blast, and frequency; response spectra, structural response and damping. Damage analysis and prediction; probabilistic study of cracking. Human response. Vibration monitoring equipment and control.

ME 548, Rock Fracturing and Fragmentation by Explosives, 3 cr, 3 cl hrs
Prerequisite: Graduate or senior standing or consent of instructor
Fundamentals of dynamic rock strength, mechanisms of fracturing and fragmentation of rocks by explosives. Theoretical treatment of rock stress induced by internal explosion, methods for computer calculations of rock damage. Brief overview of devices, accessories, and methods used in industrial applications of fragmentation.

ME 549, Shock Wave Theory, 3 cr, 3 cl hrs
Prerequisites: MATH 335
An in-depth study of the propagation of shock waves in various media. Derivation and application of the Rankine-Hugoniot jump equations. The concepts of the rarefaction wave and various wave interactions. Derivation and applications of the Mie-Gruneisen equation of state. Differential form of the conservation equations, as well as numerical solutions for simple cases. Current hydrocodes. (Same as EM 549)

ME 550, Advanced Explosives Engineering, 3 cr, 3 cl hrs
Prerequisites: MATH 335
Detonation of non-ideal explosives, equation of state for porous media, shaped charge effect and explosively formed projectiles. Shock compaction of powder, explosive welding, and experimental methods used to evaluate explosives and their applications. The dynamic fracture of ductile and brittle materials. (Same as EM 550)

ME 551, Industrial Minerals, 3 cr, 3 cl hrs
Prerequisites: Graduate standing or consent of instructor
Offered alternate years
Study of basic concepts of production and use of industrial minerals in modern society. Emphasis on complex interactions between economics, geology, processing, marketing, and transportation. Seleted industrial minerals studies in detail. Several field trips to operations and occurrences. (Same as GEOL 551)

ME 552, Applied Explosives Engineering, 3 cr, 3 cl hrs
Prerequisite: Graduate or senior standing or consent of instructor
Commercial and other applications of explosives. Basics of thermal decomposition, explosion, shock initiation, and detonation. Laboratory methods of performance evaluation of explosives including shock initiation tests and underwater explosion tests. Techniques of forming and shaping of detonation waves. Some unusual applications of explosives in creating large magnetic fields.

ME 553, Computer Modeling of Detonations (3)
Prerequisites: ME 539 or ES 549; ME 550; or consent of instructor
Introduction to hydrodynamic modeling applied to explosives. Numerical methods for modeling shock physics, detonation, and material response. Finite difference, finite element and smoothed particle hydrodynamic methods, equation of state and strength models, numerical fracture and fragmentation. (Same as EM 553)

ME 556, Detonation Theory, 3 cr, 3 cl hrs
Prerequisites: ME 549 or ES 549; ME 550 or ES 550; or consent of instructor
Development of classical detonation model for full-order detonation of secondary explosives. Ideal versus non-ideal detonation. Burn-rate models for pyrotechnics. The concept of deflagration to detonation transition. (Same as EM 556)

ME 561, Advanced Topics in Engineering Geology, 3 cr, 3 cl hrs
Offered on demand
Study of special topics in geologic hazards, site characterization, and related fields of interest in engineering geology.

ME 562, International Mining Field Trip, 3 cr, 3 cl hrs
Field trip in conjunction with the Student Chapter of the Society of Economic Geologists to a geologic and mining interest in a foreign country, usually Chile. Seminar-style class with a required term paper. Students are responsible for preparation of a field-trip guidebook, to be used by students and professionals participating in the field trip.

ME 563, Field Studies in Hydrothermal Alteration, 3 cr, 3 cl hrs
Prerequisites: GEOL 211; GEOL 318 or 319 or equivalent; ME 360 or GEOL 480
A field and lab-based course emphasizing the geochemistry and mineralogy of hydrothermal ore deposits, with substantial hands-on exercises and field-based descriptive work. Lab exercises utilize thin section and polished section samples from hydrothermal ore deposit suites to demonstrate variations in protolith and alteration mineralogy, and result in the production of professional-style reports, interpreting the geochemical and exploration significance of the alteration assemblages observed. Field trips to mineral deposits emphasize the areal extent of hydrothermal alteration associated with porphyry, epithermal and skarn-style ore deposits.

ME 565, Mine Waste Characterization, 3 cr, 3 cl hrs
Prerequisite: Consent of instructor
Environmental aspects of mine waste materials. Geologic, geochemical, and engineering evaluation of tailings, waste rock dumps, and processing chemicals. Sampling and mineralogic analysis of mine wastes. Characterization of physical, chemical, and biological environments surrounding mine sites. Current environmental and mining regulations. Field trips, laboratory studies, and case histories.

ME 566, Mine Waste Management and Control, 3 cr, 3 cl hrs
Prerequisite: ME 565
Control of wastewater and solid pollutants from mining and processing of minerals. Design of facilities to control and manage waste streams resulting from mine and mill operations. Mine land reclamation and closure design. Design projects and field trips.

ME 570, Advanced Topics in Explosives Engineering, 3 cr, 3 cl hrs
Prerequisite: Consent of instructor
Study of special topics in the application of explosives in the fields of rock blasting, structure response to vibrations, and ordnance.

ME 571, Advanced Topics in Mineral Engineering, 2–3 cr

ME 572, Graduate Seminar, 1 cr, 2 cl hrs
Prerequisite: Graduate standing
Presentation and discussion of research ideas, including presentation of published papers.

ME 581, Directed Study, 1–3 cr

ME 590, Independent Study, cr to be arranged
Independent research organized and conducted by the student under the direction of the student's advisor. Written final report and oral presentation required.

ME 591, Thesis (master's program), cr to be arranged

Staff Research Interests

Aimone-Martin—Drilling and Blasting, Geotechnical Engineering, Mineral Evaluation, Geostatistics
Barker—Industrial Minerals
Chávez—Applied Mineral Exploration, Ore Deposits, Natural Resource Utilization
Fakhimi—Geomechanics, Numerical Modeling
Gundiler—Hydrometallurgy and Mineral Processing
Kozushko—Mine Design, Support and Reinforcement Design, Underground Safety
C. Mojtabai—Natural Resources Law
N. Mojtabai—Site Investigation, Rock Fragmentation, Mine Design, Geomechanics
Oravecz—Rock Mechanics
Walder—Geochemistry, Mine Reclamation, Mine Waste Characterization
Wolski—Mine Design, Ventilation