COLLEGE OF ENGINEERING

Mining & Geological Engineering

GRADUATE COURSES

SPRING COURSES

MNE 502 - Probability and Statistical Concepts in Geologic Media
Covering Univariate probabilistic and statistical methods, data reduction, basic probability concepts, discrete and continuous probability distributions, sampling distributions, confidence intervals, goodness-of-fit-tests, regression analysis, machine learning and big data, applications in geologic media. Introduction to R language.

MNE 503B - Technical Leadership for Engineers II
This course advances the concepts of technical leadership in today's modern engineering profession. The increasing complexity of advanced technological systems require technical leaders who understand and can solve complex problems from multiple engineering perspectives. This course applies a "systems thinking" approach that looks at problem sets holistically to solve engineer physical or non-physical systems. This course examines engineering technical leadership from the perspective of leading and managing work force talent through effective integration of people, organization, processes, and resources.

MNE 504F - Metallurgical Inputs to Integrated Planning
This mini-course is designed to help students and junior- to mid-level professionals in the mining industry better understand the role of mineral processing and extractive metallurgy in the mineral resources industry. Topics include the fundamentals of mineral processing and extractive metallurgy operations, process design options and decision analysis, metallurgical testing and modeling, and the theory and practice of comminution, separation, hydrometallurgy, and pyrometallurgy. The main focus is on copper, silver, and gold ores. No prior knowledge of mineral processing or metallurgy is required.

MNE 514 - Mine Tailings Monitoring & Management
The course introduces and examines key principles, regulations, risk factors and practical strategies to monitor and mitigate the risks and hazards associated with mine tailings facilities. The course is focused on the scientific and engineering principles supporting tailings monitoring activities, standard and innovative technologies are covered. Activities will include data interpretation exercises, individual and team projects based on real-world examples and data, as well as guest lectures from industry professionals.

MNE 517 - Tailings Storage Facility Design (Planning,Design and Analysis)
Tailings Storage Facility design (operation) is a multidisciplinary enterprise which requires broad background knowledge in many diverse fields: geotechnical engineering, mining engineering and mineral processing engineering. The responsibility for tailings disposal operation is usually given to mill superintendent or metallurgical engineer, and mining engineers are sometimes confronted with the problems of embankment slope stability and seepage. Thus, it is required for mine operator/engineers to have (preparatory) background knowledge related with Tailings Storage Facility design and operation. This course provides a link between the various technical disciplines. The course includes engineering behavior of tailings, various tailings disposal methods, impoundment water control, and embankment slope stability/seepage analysis using the computational modeling software. Graduate level students will have additional assignments and projects (presentations and technical reports) assigned.

MNE 518 - Geometallurgy
This course is designed to introduce students to the theory and practice of geometallurgy and the role of mineralogy in mine planning, ore processing, and mine development. Topics include spatial distribution and variability of minerals in ore deposits, mineral behavior and element deportment during ore processing, and industry practices in geometallurgical sampling, testing, materials characterization, and planning. The laboratory section introduces industrial methods of mineral characterization (including SEM, XRD, and MLA) and provides hands-on examination of mineral processing samples from various deposit types

MNE 520 - Data Analysis and Application Development for Mining Engineers

An introduction to programming, specifically, developing scripts to automate data analysis and mine planning tasks. Emphasis is placed on working in the Windows environment. Topics include scripting (CMD, Powershell, Perl, Python), cloud tools (storage, collaboration, CRM, ERP, IAAS), Generic Mapping Tools (GMT), application development on the Windows platform in Matlab and Python, application development on the Android and iOS platforms, social media data mining, spatial and time series data analysis, database creation and manipulation, and web page development. The course provides hands-on experience with practical examples drawn from tasks commonly performed in the mining industry. The course is "lab based", that is, a short presentation followed by hands-on computing exercises on laptops for the remainder of the class period. Homework assignments are designed to develop a working knowledge of a wide range of computing tools. Graduate-level requirement includes additional term project with a wider and more detailed scope of work, and advanced data analysis and application development.

MNE 525 - Mine Emergencies and Disasters: Prevention, Response, and Recovery

Effective and efficient prevention, response, and recovery from emergencies and disasters is a business necessity for every mine operation. Prevention relies on risk management and safety systems built on risk identification, root cause delineation, measurement, and monitoring which are strengthened and optimized by regular evaluation using exercises. Disaster response that mitigates the severity of the actual emergency requires tools and specialized training that help bring calm during chaos with tangible results (e.g., saved lives, saved environment, saved infrastructure, and saved equipment). The infrastructure needed for effective mine disaster response includes components ranging from incident command, miner self-escape, aided escape, and mine rescue. Following mitigation of the most severe aspects of the emergency, the organization begins the process of recovery that returns the mine to a safer operation than before the event. Recovery considers a spectrum of impacts to personnel (physical and psychological trauma), the environment (contamination), infrastructure (damage to ground control, ventilation, and data systems), and equipment (cost and length of time to replace/repair damaged machinery). This course will dive deeply into the history of major US mine disasters and resultant federal regulatory responses, best practices in risk management and safety systems, incident command systems including self-escape and mine rescue, and application of business continuity plans to efficiently and effectively return the mine to a state of safe operation.

MNE 536 - Surface Mine Planning and Design

Open pit mine design and planning, incorporating the principles from prior mining and engineering courses. Functions of a mine engineer include the mine development process, resource and reserve analysis, economic pit limit determination, pit and phase design, production planning, cash flow analyses and social and environmental considerations. Laboratory design problems and work are associated with typical mine design and planning functions by using the MinePlan software.

MNE 538 - Underground Mine Design

Understand and apply concepts and problem-solving methods for the design of underground facilities, and operation of underground mines for ores, evaporites, and coal. Topics will include design and layout of excavations, including adits, shafts and slopes, stopes, undercuts and vehicular roadways; mining methods for various geological conditions, sequence of operations (cyclic and continuous), basic design of mine services and equipment selection including ventilation, material-handling, hoisting, electric distribution and dewatering. Safety considerations will be paramount. At the conclusion of the course, participants will be able to select a mining method based on geologic conditions, and perform mine layout, equipment selection and services determination for a target underground production rate. Graduate-level requirements include a Critical Topic Analysis worth 15% of grade

MNE 539 - Surface Chemistry of Flotation

The course is to deliver the fundamentals of surface chemistry of flotation in mineral processing. It covers the concepts and principles of the thermodynamics (wetting and adsorption) at the interface, the definition and measurement of surface force in flotation, the DLVO theory and colloid stability, the methods and techniques for surface analysis, and finally the chemistry and mechanism of the chemicals (collector, frother and modifier) applied in flotation

MNE 547 - Underground Construction Geomechanics

MNE 550 - Elements of Solution Mining

MNE 576 - Mine Ventilation

An introduction to the principles, applications, analysis, and design of subsurface ventilation systems. Topics covered include thermodynamics properties of air, ventilation planning, design, survey, and network analysis, fan types, impeller theory, fan laws, and ventilation (fan) economics, mine heat, gases and dust, governing regulations, and environmental consideration. Computer applications, laboratory work and intensive field trip further enhance the understanding of the fundamental concepts. Graduate-level requirements include completing a more complex project which will include more advanced tasks related to design, simulation, interpretation of data, and presentation of scientific information.

MNE 580 - The Mechanics of Fracture in Rock and Other Brittle Materials

Fracture mechanics theory applied to the deformation and failure of rock; numerical techniques; micromechanical damage models; flow through fractures; the mechanics of faulting and earthquake rupture.

MNE 583 - Introduction to Moon Mining

There is a major change in the search of new sites for the extraction of minerals and other natural resources which are located out of the Earth. In particular, the Moon has been designated as the next destination for mining operations. This could comprise base metals, construction materials, rare earths, and water, being the latter a resource that may create high expectations for its value for the off-World human settlements. The mining methods and techniques for the successfully technical and economic production is the central aspect of this course. Equipment and technologies specially designed for working under the unique conditions found on the Moon (low gravity, extreme temperatures, drastic changes from intense light to absolute darkness, high radiation, and the lack of atmosphere) are also considered in the design of the sites for pioneering mining operations on the Lunar surface or underneath. Open-source tools will be utilized for managing topographical maps and solid modeling shapes, to produce production plans, economic assessments, and realistic animations for representation of proposed production projects are included.

FALL COURSES

MNE 503A - Technical Leadership for Engineers I

This course introduces the concepts of technical leadership in today's modern engineering profession. The increasing complexity of advanced technologies and systems requires a new generation of technical leaders who are creative, independent, and innovative to think, understand and solve complex problems from multiple engineering perspectives. This senior level course leverages the principles of systems engineering by applying a "systems thinking" approach to solving complex industrial problems in today's continuous challenging technical environments. This course examines the critical roles and functions of leadership and management for technical engineers. Topics include leadership by example, professional ethics, creating and developing effective teams, relationship building, influencing, and leading and managing change through creativity and innovation. This course also analyzes leadership attributes as a means to understand what makes a successful or failed leader. There will be assigned case studies that analyze these attributes.

MNE 507 - Equipment Operations Technology

Ideal for mining, civil, and industrial engineers to learn the processes of designing, justifying, implementing, operating, and maintaining large-scale heavy equipment based earthmoving systems. Trucks, Shovels, Front End Loaders, Scrapers, Draglines, Dozers and Rippers, Conveyor Belts, Crushers, Bins, Hoppers. What do all have in common? They are machines. They help us to do a safer, faster, and more efficient work at a mine. The course will focus on methods of materials movement and transportation for both surface and underground including technological developments in areas such as automation, tele-remote operations, performance analysis, equipment productivity and selection, maintenance, and operations research. Graduate-level requirements include an individual graduate project.

MNE 511 - 001   Mineral Processing

The course covers the principles, methods and equipment of diverse beneficiation processes to separate and recover the economic minerals and metals from their ores. Major mining operations in AZ are introduced with the flowsheets being analyzed. The modern scientific and engineering background for the operations are presented as well as the mitigation of mining activities impact on environment. Graduate-level requirements include an advanced understanding of the fundamentals and solutions

MNE 515 - Rock Excavation

Methods of excavation of rock in surface and underground mines and construction, ranging from the empiricism of conventional blasting practice to the application of the fundamental mechanics of rock fracture. Graduate-level requirements include a research project.

MNE 520 - Data Analysis and Application Development for Mining Engineers

An introduction to programming, specifically, developing scripts to automate data analysis and mine planning tasks. Emphasis is placed on working in the Windows environment. Topics include scripting (CMD, Powershell, Perl, Python), cloud tools (storage, collaboration, CRM, ERP, IAAS), Generic Mapping Tools (GMT), application development on the Windows platform in Matlab and Python, application development on the Android and iOS platforms, social media data mining, spatial and time series data analysis, database creation and manipulation, and web page development. The course provides hands-on experience with practical examples drawn from tasks commonly performed in the mining industry. The course is "lab based", that is, a short presentation followed by hands-on computing exercises on laptops for the remainder of the class period. Homework assignments are designed to develop a working knowledge of a wide range of computing tools. Graduate-level requirement includes additional term project with a wider and more detailed scope of work, and advanced data analysis and application development.

MNE 522 - 001 Engineering Sustainable Development

This course is for students who wish to learn and engage in modern sustainable development practices with respect to engineering projects that have three areas of impact: economic, environmental, and societal. The course will provide background for an understanding of the complexities and inter-relations of sustainable development issues. Although the primary focus will be on the minerals development industry and the impacts in industrialized and developing nations, communities and the environment, the course will also relate to other industries. Graduate-level requirements include an additional independent research project and class presentation.

MNE 524 - Miner Health: Fitness-for-Duty, Mitigating Exposures, and Managing Disease Risk

Mitigating mining-related disease risks requires a spectrum of tools ranging from hazard identification and exposure measurement to control validation and measuring employee fitness-for-duty. From the context of real-life mining scenarios and business cases, the course will cover mining-related diseases, industrial hygiene, and occupational medicine approaches for anticipating, recognizing, evaluating, and controlling mining hazards and measuring miner fitness-for-duty; with the primary focus on recognizing and evaluating hazards and managing risk through controls and regulatory compliance. The course will dive deeply into the cause-effect of miner health and diseases while emphasizing the qualitative and quantitative assessment tools to validate controls and mitigate health risks. Techniques will be applied for hazard identification, quantification of risk, and appropriate application of the hierarchy of controls

MNE 526 - Health and Safety in Mining

Fundamental concepts in the recognition, evaluation and control of health and safety hazards encountered in mining operations; includes a review of engineering management responsibilities to control accidents, a review of federal regulations and standards affecting the industrial workplace, and instruction regarding the interaction of industrial hygiene, safety, fire protection and workers' compensation to control losses resulting from industrial accidents. Graduate-level requirements include a term paper.

MNE 527 - Geomechanics

Mechanical behavior of rock and rock masses; lab testing and intact rock failure criteria; rock discontinuities and rock mass classification; modern rock mass characterization tools; rock mass strength criteria; in-situ stress state; induced stresses due to underground excavations; numerical stress and discontinuity characterization software; rock slope stability; engineering applications including highway and mining slopes, tunnels and underground mining, dam foundations, national monuments. Graduate-level requirements include either a research project or a research paper and a presentation, at the discretion of the instructor.

MNE 530 - Mine Examination and Valuation

Principles and procedures in mineral property valuation, time value of money fundamentals. Ore reserve estimation using geostatistics techniques, cut-off determination, and engineering economics. Investment analysis of actual mining and non-mining industries. Development of criteria for Discount Rate selection. Case Studies of actual mining companies and the way they address economic and technical challenges for sustaining the production of mineral commodities. Graduate-level requirements include either a research project, a complete lecture, or a research paper at the discretion of the instructor.

MNE 541 - Environmental Management and Mine Reclamation

Principles and practices of mine environmental management and reclamation; pre-mining assessment. Design of water management systems (contaminant removal; settling ponds, groundwater protection); recontouring and revegetation; air quality management; noise and seismic mitigation. Monitoring methods for tailings, slopes and water. Maintaining permits; closure and bond release and ultimate land use. Best management practices. Graduate-level requirements include additional assignments and a research paper or presentation on a specific environmental management topic.

MNE 542 - Application of Discrete Event Simulation in Mining

Mine planning involves making decisions at different stages of a mining operation that meets stakeholders' goals given operational and regulatory constraints. Suboptimal decision-making often leads to unsustainable resource exploitation. Therefore, it is important to minimize risk and evaluate all feasible alternatives in decision-making to achieve an efficient mine plan. The first part of this course introduces students to the process of identifying, quantifying, and managing the economic risk inherent in mining as part of the decision-making process (using Monte Carlo simulation). Second, discrete event simulation (in Arena®) is used to select "the best option," such as the optimal number of haulage equipment, given operational risks to meet stakeholders' goals.

MNE 544 - Geopositioning for Mining Applications

Geopositioning techniques as applied in the mining industry. Topics cover Global Positioning System (GPS), Photogrammetry, Remote Sensing, Modern Mapping and Scanning Instruments, Geographical Information System (GIS). The materials covered support concepts and topics discussed in other mining courses by allowing the students to collect, process and analyze digital data and use the information to design ventilation system, rock blasting, underground support system, mining sequences, monitor subsidence and slope movements, and simplify the reclamation process. The course is comprised of a lecture period where concepts related to each of the topics listed above will be discussed, and a hands-on portion, which provides the students the opportunity to operate a GPS, motorized total station, and LIDAR scanner in order to acquire data and analyze the collected information using advanced processing software. Graduate-level requirements include additional term project with a wider and more detailed scope of work, and advanced data analysis and interpretation.

Geomechanics Certificate Required Courses (12 units):

- MNE 527 Geomechanics
- MNE 580 Rock Fracture Mechanics
- MNE547 Underground Construction Geomechanics
- MNE 515 Rock Excavation

Elective Courses (3 units)

You choose an elective course with the approval of the program advisor.

Examples include:

- CE 540 Soils Foundation Engineering (3)
- CE 541 Earth Structures (3)
- MNE 506A Mine Ventilation (3)
- MNE 909 Project (1-3)

Mining Occupational Health and Safety Certificate Required Courses (7 units):

- MNE 506A Mine Ventilation (3)
- MNE 526 Mine Health and Safety(1)
- CPH 553 Toxicology and Chemical Exposures (3)

Elective Courses (at Least 8 units):

- CPH 522 Safety Fundamentals (3)
- CPH 576A Biostatistics (3)
- MNE 521 Disease & Illness In Mining (3)
- MNE 527 Geomechanics (3)
- MNE 547 Underground Construction Geomechanics (3)
- CPH 577 Social And Behavioral Aspects Of Public Health (3)
- CPH 574 Health Administration And Policy (3)
- CPH 575 Environmental And Occupational Health (3)
- CPH 573A Basic Principles Of Epidemiology (3)

Mine Production and Information Technology Certificate Required Courses (9 units):

- MNE 507 Equipment Operations Technology (3)
- MNE 509 Management Operations Technology (3)
- SIE 554A The Systems Engineering Process (3)

Elective Courses (Choose two):

- MNE 587 Applied Neural Network Computing (3)
- SIE 531 Simulation Modeling & Analysis (3)
- SIE 530 Engineering Statistics (3)
- SIE 548 Operations Research Modeling (3)

Mineral Processing and Extractive Metallurgy Certificate Required Courses (12 units):

- MNE   511 Mineral Processing (3)
- MNE 539 Surface Chemistry of Flotation (3)
- MNE 550 Elements of Solution Mining (3)
- MNE 565 Hydrometallurgy (3)

Electives:

- MNE 518 - Geometallurgy
- MNE 541 - Environmental Management and Mine Reclamation

Master of Engineering Mining and Geological Engineering Core Courses

1. **Business Fundamentals** (at least 3 units).
   Courses that meet the requirement include MNE 530 and SIE 557.
2. **Applied Engineering/Mathematics** (at least 3 units).
   Courses that meet the requirement include MNE 520, BE 513 and SIE 530.
3. **Entrepreneurship/Innovation/Design** (at least 3 units).
   Courses that meet the requirement include MNE 515, MNE 536 and SIE 567.
4. **Advanced Engineering Science** (at least 3 units).
   Courses that meet the requirement include MNE 507, MNE 511 and MNE 527.

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

GEOMECHANICS
MNE 527 Geomechanics (3-4)
MNE 547 Underground Construction Geomechanics (3)
MNE 580 The Mechanics of Failure in Rock and Other Brittle Materials (3)
MNE 515 Rock Excavation (3)
MNE 517 Tailings Storage Facility Design (3)

MINE INFORMATION AND PRODUCTION TECHNOLOGY
MNE 507 Equipment Operations Technology (3)
MNE 519 Mine Planning Software (short course) (1)
MNE 536 Surface Mine Design (3)
MNE 538 Underground Mine Design (2)
SIE 531 Simulations Modeling and Analysis (3)
SIE 554A The Systems Engineering Process (3)

MINE HEALTH AND SAFETY
EPID 573A Basic Principles of Epidemiology (3)
PHPM 574 Health Administration and Policy (3)
EHS 575 Environmental and Occupational Health (3)
BIOS 576A Biostatistics (may be used to satisfy math requirement) (3)
HPS 577 Social and Behavioral Aspects of Public Health (3)
MNE 522 Engineering Sustainable Development (3)
*MNE 523 Historic and Contemporary Role of US Regulatory Agencies (OSHA, MSHA, EPA) (3)
MNE Miner Health: Fitness-for-Duty, Mitigating Exposures, and Managing Disease Risk (3)
*MNE 525 Mine Emergencies and Disasters – Prevention, Response, and Recovery (3)
MNE 526 Health and Safety in Mining (1)
MNE 576 Fundamentals of Mine Ventilation (4)

MINERAL PROCESSING
MNE 511 Mineral Processing (3)
MNE 539 Surface Chemistry of Flotation (3)
MNE 550 Elements of In-situ Leaching (3)
MNE 565 Hydrometallurgy (3)
MNE 567 Applied Pyrometallurgy (3)

SUSTAINABLE RESOURCE DEVELOPMENT
BE 526 Soil and Water Conservation Engineering (3)
AREC 576 Natural Resource Law and Economics (3)
MNE 522 Engineering Sustainable Development (3)
MNE 541 Environmental Manaegment and Mine Reclamation (3)

mge.engineering.arizona.edu