MSc in Mining Engineering

Year 1 - Fall

MINE 501 - Foundations of Mining
Survey of mining and mining economics. Topics include mining law, exploration and sampling, reserve estimation, surface and underground mining methods, mine planning and design, geomechanics design and hydrogeology, mineral processing, mine ventilation, project evaluation and mine feasibility studies, risk management,. Basic unit operations including drilling and blasting, loading and hauling, support systems and shaft sinking.Bachelor's degree.

Course learning outcomes
1. Demonstrate an understanding of the fundamental definitions and terminologies of mining engineering.
2. Demonstrate an understanding of mining unit operations including drilling, blasting, loading and hauling.
3. Compare and explain different surface and underground mining methods.
4. Explain the basics of mining economics.
5. Outline the current industrial technology and applications.
6. Analyze overall industry statistics based on region and country.

MINE 504 - Mine Geomechanics

The objective of the course is for the students to develop an understanding of the fundamentals of soil and rock mass mechanical behavior including soil, intact rock and rock mass physical and mechanical properties.

Course learning outcomes
1. Explain most aspects of the fundaments of the mechanical behaviors of rock and soil including: typical stress-strain curve of rock, constitutive laws, pore pressure, seepage, strength (uniaxial, biaxial, triaxial and shear) failures, soil compaction, phase relationship of soils.
2. Determine the physical and mechanical properties of soil and intact rock in a laboratory setting with ISRM and ASTM standards;
3. Determine in-situ rock mass and discontinuity properties.
4. Create stereographic projection plots (stereonets) of structural data and interpret the results.
5. Apply appropriately Hoek-Brown and Mohr-Coulomb failure criteria to solve basic problems related to rock and soil mechanics.
6. Evaluate stress distribution around excavations using the analytical method (Kirsch equations) and numerical methods (Rocscience or Map3D software).
7. Characterize rock mass using the GSI, RMR and Q rating systems for underground and surface mining.

MINE 503 - Applied Geostatistics

This course familiarize the students with the process of geological block modeling that is applicable for further analysis of mining activities (e.g. mine planning). It covers the traditional and modern algorithms for mineral resource estimation and reporting based on JORC code associated with discussion of the advantages and disadvantages in each. Beside of that, the most widespread applied Geostatistical tools such as variogram, kriging, simulation and change of support will be thoroughly discussed.

Course learning outcomes
1. Describe the data structures and integrated technologies required for practical 3D application of geostatistics.
2. Evaluate the current methodology for resource estimation and choose the optimum one according to the type and complexity of a deposit.
3. Analyze the block model and preparation for calculation of recoveries function (tonnage, mean grade above cut-off and metal quantity).
4. Apply simulation methods in resource estimation and probabilistic modeling of recovery functions.

5. Critically evaluate and manage uncertainty in resource estimation.

MINE 502 - Geology for Mining Engineers

This is an introductory course specifically designed for students in mining engineering to give them the necessary background in geology they will need in their future professional career. The course is a condensed version of several more in-depth courses proposed in the B. Sc. Geology program.

Course learning outcomes
1. Discuss the geological processes involved in the genesis of ore deposits.
2. Relate the physical properties of minerals and rocks to their mechanical behavior in a mining environment.
3. Apply the principles of structural geology and engineering geology in the context of mine design.

MINE 505 - Advanced Mine Ventilation

Advanced topics of mine ventilation, including specific ventilation designs for various mining methods, ventilation modeling, mine atmosphere management, mine air cooling and heating, prevention and ventilation response to mine fires and explosions, mine dust, gas, temperature, humidity control.

Course learning outcomes
1. Apply mine ventilation design and modelling for different underground mining methods and work with mine air cooling and heating, and dust and aerosols control.
2. Evaluate the concept of safe coal mine working environment by suitable mine ventilation practice.
3. Critically audit mine ventilation legislations and analyze mine atmosphere management, risk assessment and hazards control.

Year 1 - Spring

MINE 509 - Advanced Surface Mine Design

Terms, fundamental and case reviews, Mineral resource modelling, Open Pit Mine Design and Optimization with emphasis on Surface mine planning, Cut-off grade, Optimal pit limit, Pit phase design and haul road design, Waste dump design and open to underground transition, Drill & Blast, Long-term and short-term planning, Load & Haul, Equipment cost estimation, fleet productivity, equipment selection, Cash flow analysis, IPCC and Dispatch system and Environmental issues. Introducing several software for design purposes such as UDEC and 3DEC.

Course learning outcomes
1. Undertake a surface mine feasibility study.
2. Apply mine design software to surface mine design studies.
3. Construct block models for use in surface mine design.
4. Demonstrate the significance of short, medium and long term mine planning.
5. Relate how to work in groups and objectively evaluate their peers.
6. Create presentations and deliver these professionally.

MINE 508 - Advanced Rock Mechanics

Analytical and numerical modeling analysis of stresses and displacements induced around engineering excavations in rock. Rock deformation and failure criteria. Measurement and monitoring techniques in rock mechanics. Principles of design of excavation in rocks. Analytical, numerical modeling and empirical design methods. Probabilistic and deterministic approaches to rock engineering designs. Excavation design examples for shafts, tunnels, large chambers and mine pillars. Seismic loading of structures in rock.

Course learning outcomes
1. Understand the fundaments of rock mass mechanical response around excavations.
2. Carry out lab testing, geotechnical mapping and/or measurement to determine rock mass parameters relevant for engineering design.
3. Classify rock masses using conventional rock mass classification systems such as the RMR and Q systems for engineering applications.

4. Analyze rock engineering designs using empirical, analytical and numerical methods; topics include pit slope stability, mine pillar design, support of underground openings, stability of stopes and longwalls.

MINE 510 - Advanced Underground Mine Design
Selection, design, and development of most suitable underground mining methods based upon the physical and the geological properties of mineral deposits (metallic, nonmetallic and coal), conservation considerations, and associated environmental impacts.

Course learning outcomes
1. Analyze different underground mining methods in order to select the most suitable methods.
2. Assess the underground mining resource.
3. Use mine design software to develop advance level mine design and planning of an underground mine and communicate the results in team environment.
4. Analyze advance level of underground design process including inputs, stope design, access design, and extraction and haulage systems.
5. Apply economic and technical data to evaluate mine plans and develop cost estimates for underground mining projects.

MINE 507 - Rock Excavation Methods

This course delivers the main rock breakage techniques used in mining including machine mining, drilling and blasting. Machine mining method comprises rock cutting principles, cutting with picks and discs, the design of cutter heads. Drilling covers drilling methods used in mining, selection and costing of drilling equipment. Blasting encompasses mechanics of explosive-rock interaction, selection of commercial explosives, the chemistry of explosives, blast design principles for surface and underground mines, safety, environmental and regulatory management and blast performance assessment and analysis

Course learning outcomes
1. Evaluate the different types of rock cutting methodologies.
2. Explain the machine mining methodology and critically evaluate the pros and cons.
3. Analyze the drilling technology in mining industry and make advanced level of comparisons including efficiency and cost.
4. Evaluate the advanced level of explosive-rock interaction.
5. Develop and design blasting layout for open pit and underground mining.
6. Critically analyze environmental and regulatory management of industrial blasting.

Year 2 - Fall

MINE 690 - Thesis I
This course aims to train the students to identify relevant research problem, perform a literature review on a research problem, develop and implement an original methodology to investigate for possible solutions to this problem.

Course learning outcomes
1. Discover and pursue a unique topic of research in order to construct new knowledge.
2. Design and conduct an original research project.
3. Develop skills in designing a discipline specific research methodology.
4. Develop a working knowledge of relevant literature in the thesis discipline.
5. Practice academic writing appropriate to the discipline and learn how to participate in the peer review process.
6. Plan research activities.
7. Prepare accurate research progress reports.
8. Discuss research and other topics with academics in the thesis discipline.

MINE 602 - Mine Automation and Maintenance
This course covers the principles of mine maintenance and services. It presents maintenance related issues and the economic importance of preventive and proactive maintenance and service management in mining operations and to develop skills in decision making in relation to effective management practices.

Course learning outcomes
1. Analyze the principle of mine maintenance and services.
2. Evaluate preventive and proactive maintenance and service management for safety operations.
3. Examine mine communications systems for effective management practices.

MINE 601 - Mine Management and Sustainability
The course covers the management principles and practices vital to a mine manager's successful running of a mining enterprise including strategic minerals management; mining law, mine safety and risk management, and operations management. Furthermore, the course also presents an understanding of the fundamental principles of sustainability and how they influence the technical components of a mine's life cycle.

Course learning outcomes
1. Understand the principles and practices of management as they apply to mining enterprise.
2. Gain knowledge of international standards and best practices in mine management.
3. Develop analytical skills related to sustainable management of mining operations.

Year 2 - Spring

MINE 691 - Thesis II
This course aims to train the students to identify relevant research problem, perform a literature review on a research problem, develop and implement an original methodology to investigate for possible solutions to this problem.

Course learning outcomes
1. Discover and pursue a unique topic of research in order to construct new knowledge.
2. Design and conduct an original research project.
3. Develop skills in designing a discipline specific research methodology.
4. Develop a working knowledge of relevant literature in the thesis discipline.
5. Practice academic writing appropriate to the discipline and learn how to participate in the peer review process.
6. Plan research activities.
7. Prepare accurate research progress reports.
8. Discuss research and other topics with academics in the thesis discipline.

Elective Courses of Year 2

MINE 606 - Underground Hard Rock Geotechnical Engineering
This course provides students with advanced knowledge in underground hard rock mechanics as required for the safe and economic extraction of ore and tunnelling in hard rocks under high stress conditions.

Course learning outcomes
1. Develop a design or a process or investigate a hypothesis following industry professional engineering standards.
2. Apply scientific and engineering methods to solve an engineering problem.
3. Analyze data objectively using quantitative and mathematical methods.
4. Demonstrate oral and written communication in professional and lay domains.

MINE 604 - Geology of Ore Deposits
The course has been organized by ore deposit type with an effort to integrate aspects of geodynamics, tectonics, petrology, mineralogy and physical chemistry which are important to establish genetic models for

ore deposits. Examples from Kazakhstan are used where possible for the purpose of illustration. The course content is the following: • Magmatic ore deposits: general characteristics of magmas, mineral/melt trace element partitioning, compatible and incompatible elements, ore formation processes in magmatic systems. Magmatic sulfide deposits (Ni, Cu, PGE). Chromite deposits (Kempirsai). • Hydrothermal ore deposits: hydrothermal systems, solution chemistry, solubility of ore minerals. Cu-Mo porphyry deposits (Aktogay). Epithermal deposits. Mid-ocean ridge hydrothermal systems. Orogenic Au deposits. • Sedimentary ore deposits: Mississippi Valley-type Pb-Zn deposits; unconformity-related, tabular and roll-front uranium deposits, redox relations with sedimentary organic matter (Chu-Sarysu basin). • Supergene ores: development of lateritic profiles, alteration of granites and formation of bauxite deposits, alteration of peridotites and formation of lateritic nickel ore deposits.

Course learning outcomes
1. Discuss the geological processes and physico-chemical conditions leading to the formation of ore deposits.
2. Describe the behavior of trace elements in geological processes and their transport by geologic fluids.
3. Identify the important ore-forming minerals.
4. Formulate conceptual genetic models for ore deposits.

MINE 603 - Multivariate Geostatistics
This course provides a practical knowledge for mineral resource estimation and modeling in the particular cases wherein the underlying deposits show complex characteristics. Geostatistical modeling of these type of deposits are somewhat challenging and require enhanced geostatistical tools and algorithms. The material in this course is applicable for resource reporting of multi-element deposits, modeling the geological domains and heterogeneous characteristics of the ore variability.

Course learning outcomes
1. Evaluate multivariate geostatistical tools for the industrial purposes in resource estimation of multi-element deposits.
2. Employ non-linear geostatistical tools for calculation of recovery functions in different cut-off grades.
3. Identify the optimum Geostatistical algorithms to model the geological domains to prepare the reliable estimation domains for mineral resource reporting.
4. Critically analyze non-stationary phenomena for mineral resource estimation of the variables with heterogeneous characteristics.
5. Assess the methods, advantages and disadvantages of the various commonly used forms of geostatistical simulation.
6. Operate computer programs (e.g. ISATIS) to generate and interpret geostatistical simulations using the various methods.

MINE 605 - Mechanized Excavation and Tunnelling
This course provides a solid background to students for tunnelling in rock masses. It is designed for students in mining, mechanical, civil, petroleum and electrical and electronical engineering with some background in rock mechanics and engineering.

Course learning outcomes
1. Examine the geotechnical properties of earth materials such as rock and soil.
2. Apply the principles of geotechnical engineering in the context of excavation and tunneling.
3. Evaluate the interaction of rock and machine parameters for estimating the project time and cost.
4. Use various present performance prediction model to estimate the performance of machines, such as TBM, roadheader.
5. Compare the different existing models and discuss advantages and disadvantages of the models for applications.