

Economics and Business

Degrees Offered

- Master of Science (Mineral and Energy Economics)
- Doctor of Philosophy (Mineral and Energy Economics)
- Master of Science (Engineering and Technology Management)
- Graduate Certificate in Resource Commodity Analytics (RCA)
- Graduate Certificate in Business Analytics
- Graduate Certificate in Product Management

Mineral and Energy Economics Program Description

In an increasingly global and technical world, government and industry leaders in the mineral and energy areas require a strong foundation in economic and business skills. The Department offers such skills in unique programs leading to M.S. and Ph.D. degrees in Mineral and Energy Economics. Course work and research emphasizes the use of models to aid in decision making. Beyond the core courses students in the Mineral and Energy Economics Program may select, in consultation with their advisor from a set of electives that fit their specialized needs and educational goals. This may include advanced courses in Applied Economics, Finance, and Operations Research.

Engineering and Technology Management Program Description

The Department also offers an M.S. degree in Engineering and Technology Management (ETM). The ETM degree program is designed to integrate the technical elements of engineering practice with the managerial perspective of modern engineering and technology management. A major focus is on the business and management principles related to this integration. The ETM Program provides the analytical tools and managerial perspective needed to effectively function in a highly competitive and technologically complex business economy.

Students in the ETM Program may select elective courses from two areas of focus: Engineering Management and Optimization or Technology Management and Innovation. The Optimization courses focus on developing knowledge of advanced operations research, optimization, and decision making techniques applicable to a wide array of business and engineering problems. The Engineering Management courses emphasize valuable techniques for managing large engineering and technical projects effectively and efficiently. The Strategy and Innovation courses teach the correct match between organizational strategies and structures to maximize the competitive power of technology with a particular emphasis on management issues associated with the modern business enterprise.

Combined Degree Program Option

Mines undergraduate students have the opportunity to begin work on a M.S. degree in Mineral and Energy Economics or Engineering & Technology Management while completing their Bachelor's degree at Mines. The Mineral and Energy Economics Combined Degree Program provides the vehicle for students to use undergraduate coursework as part of their Graduate Degree curriculum. For more information please contact the EB Office or visit econbus.mines.edu.

Graduate Certificate in Resource Commodity Analytics

The Mines graduate certificate in Resource Commodity Analytics (RCA) is a four-course program that provides training in advanced quantitative and financial analysis applied to energy and mineral industries. The RCA certificate program takes the most quantitative aspects of our world-renowned graduate programs in Mineral and Energy Economics, and Engineering and Technology Management, and distills them into an accelerated certificate. This program is designed for professionals and recent graduates who want to acquire new skills for career advancement or get a head start on a graduate degree. Courses in the program focus on natural resource markets & regulation, data analysis & forecasting, and financial valuation. The course of study is flexible enough to be completed in one intensive semester or over four semesters depending on the student's needs and interests.

In an increasingly global and technical world, government and industry leaders in the mineral and energy areas require a strong foundation in economic and business skills. The Division offers such skills in unique programs leading to MS and PhD degrees in Mineral and Energy Economics. Course work and research emphasizes the use of models to aid in decision making. Beyond the core courses students in the Mineral and Energy Economics Program select, in consultation with their advisor, from a set of electives that fit their specialized needs and educational goals. This may include advanced courses in Applied Economics, Finance, and Operations Research.

The Division offers the following programs whose requirements are specified on this page:

1. MS in Mineral and Energy Economics
2. PhD in Mineral and Energy Economics
3. Mines' Combined Undergraduate/Graduate Degree Program
4. Colorado Mesa University Combined Undergraduate/Graduate Degree Program
5. Western Colorado University Combined Undergraduate/Graduate Degree Program
6. IFP School Dual Degree Program

I. MS in Mineral and Energy Economics Program Requirements

MS Degree Students choose from either the thesis or non-thesis option in the Master of Science (MS) Program and are required to complete a minimum total of 36 credits (a typical course has 3 credits). Initial admission is only to the non-thesis program. Admission to the thesis option requires subsequent application after at least one full-time equivalent semester in the program.

Non-thesis option

| | |
|---------------------------|-------------|
| Core courses | 15.0 |
| Approved electives* | 21.0 |
| Total Semester Hrs | 36.0 |

Thesis option

| | |
|---------------------------|-------------|
| Core courses | 15.0 |
| Research credits | 12.0 |
| Approved electives* | 9.0 |
| Total Semester Hrs | 36.0 |

* Non-thesis MS students may apply six elective credits toward a nine hour minor in another department. See below for details.

Further Degree Requirements

All thesis and non-thesis students in the Mineral and Energy Economics Program are required to attend the Distinguished Lecture Series sponsored by the Payne Institute for Earth Resources and the Division of Economics and Business. This series facilitates active involvement in the Mineral and Energy Economics Program by top researchers and influential leaders in the policy arena. The Program Director will outline attendance requirements at the beginning of each fall semester.

Required Course Curriculum

All MS students in Mineral and Energy Economics are required to take a set of core courses that provide basic tools for the more advanced and specialized courses in the program.

a. Core Courses

| | | |
|---------------------------|---|-------------|
| EBGN509 | MATHEMATICAL ECONOMICS | 3.0 |
| EBGN510 | NATURAL RESOURCE ECONOMICS | 3.0 |
| EBGN521 | MICROECONOMICS OF MINERAL AND ENERGY MARKETS | 3.0 |
| EBGN590 | ECONOMETRICS I | 3.0 |
| EBGN594 | TIME-SERIES ECONOMETRICS <small>An alternative econometrics elective may be substituted for EBGN594</small> | 3.0 |
| Total Semester Hrs | | 15.0 |

b. Approved Electives (21 credits for MS non-thesis option or 9 credits for MS thesis option)

All EBGN graduate courses are approved electives. Other courses outside of Economics and Business can be counted with advisor and program director approval.

Prerequisites for the Mineral and Energy Economics Programs

Students must have completed the following undergraduate prerequisite courses prior to beginning the program with a grade of B or better:

1. Principles of Microeconomics;
2. One semester of college-level Calculus;
3. Probability and Statistics

Minor from Another Department

Non-thesis MS students may apply six elective credits towards a nine hour minor in another department. A minor is ideal for those students who want to enhance or gain knowledge in another field while gaining the economic and business skills to help them move up the career ladder. For example, a petroleum, chemical, or mining engineer might want to learn more about environmental engineering, a geophysicist or geologist might want to learn the latest techniques in their profession, or an economic policy analyst might want to learn about political risk. Students should check with the minor department for the opportunities and requirements.

Transfer Credits

The student must have achieved a grade of B or better in all graduate transfer courses and the transfer credit must be approved by the

student's advisor and the Division Director. The total number of transfer credits allowed in the Mineral and Energy Economics program will follow Colorado School of Mines Graduate School rules.

II. PhD in Mineral and Energy Economics Program Requirements

PhD Degree Doctoral students develop a customized curriculum to fit their needs. The degree requires a minimum of 72 graduate credits that includes course work and a thesis.

Course work (requires advisor and committee approval)

| | |
|---------------------------|-------------|
| First year Core courses | 15.0 |
| Extended Core | 3.0 |
| Approved electives | 18.0 |
| Total Semester Hrs | 36.0 |

Research credits

| | |
|------------------|------|
| Research credits | 36.0 |
|------------------|------|

The student's faculty advisor and the doctoral thesis committee must approve the student's program of study and the topic for the thesis.

Qualifying Examination Process

Upon completion of the first-year core course work, PhD students must pass a first set of qualifying written examinations (collectively Qualifier 1). A student will receive one of four possible grades on the Micro Economics and Quantitative Methods examinations: High Pass, Pass, Marginal Fail, or Fail. A student receiving a marginal fail on one, or both of the examinations will have the opportunity to retake the relevant examination(s) within a year of the initial attempt. Students receiving a marginal fail should consult their advisor as to whether to retake exams during the winter or summer breaks. A student receiving a Fail, or consecutive Marginal Fails, will be dismissed from the program. Consistent with university policy, the faculty will grade and inform students of qualification examination results within two weeks of the examinations.

Upon completion of the extended core (typically in the second year), PhD students must pass a second qualifying written examination (Qualifier II). A student will receive one of four possible grades on Qualifier II: High Pass, Pass, Marginal Fail, or Fail. A student receiving a Marginal Fail on Qualifier II will have the opportunity to retake the exam, or relevant portions of the exam as determined by the examination committee, within a year of the initial attempt. Students receiving a marginal fail should consult their advisor as to whether to retake exams during the winter or summer breaks. A student receiving a Fail or consecutive Marginal Fails, on Qualifier II will be dismissed from the program. Consistent with university policy, the faculty will grade and inform students of qualification examination results within two weeks of the examinations.

Following a successful thesis-proposal defense and prior to the final thesis defense, a student is required to present a completed research paper (or dissertation chapter) in a research seminar at Mines. The research presentation must be considered satisfactory by at least three Mines faculty members in attendance.

Required Course Curriculum

All PhD students in Mineral and Energy Economics are required to take a set of core courses that provide basic tools for the more advanced and specialized courses in the program.

a. Core Courses

| | | |
|---------|--|-----|
| EBGN509 | MATHEMATICAL ECONOMICS | 3.0 |
| EBGN510 | NATURAL RESOURCE ECONOMICS | 3.0 |
| EBGN521 | MICROECONOMICS OF MINERAL AND ENERGY MARKETS | 3.0 |
| EBGN590 | ECONOMETRICS I | 3.0 |
| EBGN594 | TIME-SERIES ECONOMETRICS <small>An alternative econometrics elective may be substituted for EBG594</small> | 3.0 |

Total Semester Hrs 15.0

b. Extended Core Courses

| | | |
|---------|-------------------------|-----|
| EBGN611 | ADVANCED MICROECONOMICS | 3.0 |
|---------|-------------------------|-----|

Total Semester Hrs 3.0

c. Approved Electives (18 credits)

The student, in consultation with their advisor, will choose six additional courses. A minimum of two courses must be Advanced Economics courses. The program of study can be customized to fit the individual student's educational goals, but must be approved by their advisor.

Prerequisites for the Mineral and Energy Economics Programs

Students must have completed the following undergraduate prerequisite courses prior to beginning the program with a grade of B or better:

1. Principles of Microeconomics;
2. One semester of college-level Calculus;
3. Probability and Statistics

Minor from Another Department

PhD students for coursework may apply six elective credits towards a nine hour minor in another department. A minor is ideal for those students who want to enhance or gain knowledge in another field while gaining the economic and business skills to help them move up the career ladder. For example, a petroleum, chemical, or mining engineer might want to learn more about environmental engineering, a geophysicist or geologist might want to learn the latest techniques in their profession, or an economic policy analyst might want to learn about political risk. Students should check with the minor department for the opportunities and requirements.

Transfer Credits

The student must have achieved a grade of B or better in all graduate transfer courses and the transfer credit must be approved by the student's advisor and the Division Director. The total number of transfer credits allowed in the Mineral and Energy Economics program will follow Colorado School of Mines Graduate School rules.

Unsatisfactory Progress

In addition to the institutional guidelines for unsatisfactory progress as described elsewhere in this bulletin. Unsatisfactory progress will be assigned to any full-time PhD student who does not pass the first year core courses on time. EBG509, EBG510 and EBG521 in the first fall

semester of study; and EBG590 in the first spring semester of study. Unsatisfactory progress will also be assigned to any students who do not complete requirements as specified in their admission letter. Part-time students develop an approved course plan with their advisor.

PhD Students are expected to take the first set of qualification examinations (Qualifier I) in the first summer following eligibility. Unsatisfactory progress may be assigned to any student who does not meet this expectation. Consistent with university policy, consideration will be given to students who have documented illness or other qualifying personal event that prevents them from taking Qualifier I. A marginal fail on a qualification examination does not trigger the assignment of unsatisfactory progress. Unsatisfactory progress will, however be assigned to a student who fails to retake a marginally failed examination in the next available summer offering.

III Mines' Combined Undergraduate/Graduate Degree Program

Students enrolled in Mines' combined undergraduate/graduate program may double count up to six credits of graduate coursework to fulfill requirements of both their undergraduate and graduate degree programs. These courses must have been passed with "B-" or better, not be substitutes for required coursework, and meet all other University, Department, and Program requirements for graduate credit.

Students are advised to consult with their undergraduate and graduate advisors for appropriate courses to double count upon admission to the combined program.

Prerequisites for the Mineral and Energy Economics Programs

Students must have completed the following undergraduate prerequisite courses prior to beginning the program with a grade of B or better:

1. Principles of Microeconomics;
2. One semester of college-level Calculus;
3. Probability and Statistics

IV. Colorado Mesa University Combined Undergraduate/Graduate Degree Program

Please see Mines Registrar Transfer Agreements web page for detailed information.

The Colorado School of Mines shares a Memorandum of Understanding (MoU) with Colorado Mesa University. Through this program Colorado School of Mines (Mines) and Colorado Mesa University (CMU), jointly provide opportunity to transition CMU Bachelor of Business Administration Energy Management/Landman graduates to Mines in order to earn a MS Non-Thesis degree. This MoU grants students with the opportunity to apply up to six undergraduate-coursework credits applied to their from Colorado Mesa University degree towards their Mines graduate-degree requirements, while also waived graduate admissions application fee, waived requirement for three (3) letters of recommendation, and exemption from submitting GRE test scores.

CMU students who successfully pass courses and meet the admission criteria of the program outlined below will be admitted to Mines at no point before the student's senior year at CMU. The student will be admitted to Mines as a Special Status graduate student. Upon successful completion of the undergraduate degree at CMU and after meeting the Mines admission criteria, students will be admitted into the Mineral and Energy

Economics MS Non-Thesis degree program and will be complete the MS Non-Thesis degree in two semesters.

CMU Students must satisfy Mines Graduate Admissions requirements as specified in the Mines catalog in effect at the time the student's application. Students who meet the admission standards are guaranteed admission into the program. Students must also meet the following requirements:

- Students must apply for Graduate Admissions before the fall deadline and no earlier than before starting the final two semesters (senior year) at CMU
- When applying, students must select the CMU Combine Undergraduate/Graduate (4+1) program on the admissions application. Official Mines approval must be granted to CMU students before the student is able to formally enter into program (4+1) agreement.
- Official approval and recommendation from CMU Department Chair must be submitted at time of application.
- Official transcripts from CMU must be submitted at the time of application to Mines and again after the undergraduate degree is conferred, but prior to the start of the term at Mines as a degree seeking student.
- The official final transcript must meet the minimum cumulative GPA that is required for admission to the Mines program. Completion of CMU Bachelor's Degree within 24 months of entering the 4+1 agreement is required.

Application procedures and deadlines

It is recommended that students talk to their CMU Energy Management/Landman advisor or department chair and the Mines Mineral and Energy Economics program director about the admissions process from CMU to Mines prior to the last two semesters of their undergraduate program. Admissions deadlines can be found online: www.Mines.edu/undergraduate-admissions/transfer-students/.

Tuition

Residency status for tuition purposes will be determined by what is provided on the admissions application. Refer to the Admissions website for residency information: <https://www.Mines.edu/graduate-admissions/>.

Enrollment Guidelines

Students will be expected to meet CMU Bachelor of Business Administration Energy Management/Landman graduation requirements. Other enrollment guidelines include the following:

Courses

Required

| | | |
|--|----------------------------------|-----|
| During the student's final two semesters at CMU, students will complete at least two of these three 400 level courses at CMU | | |
| EMGT440 | ENERGY LAND PRACTICES | 3.0 |
| EMGT450 | ENERGY LAND PRACTICES II | 3.0 |
| EMGT410 | ENERGY REGULATION AND COMPLIANCE | 3.0 |

Students must receive a grade of B or higher.

Students will be eligible to transfer six (6) credits of 500-level courses from CMU (which were not used to meet any CMU graduation requirement) to Mines per Mines transfer policy.

Any 500-level courses from CMU

After completion of their CMU Bachelor of Business Administration Energy Management/Landman degree, students will be fully admitted into the Mineral and Energy Economics Mines Non-Thesis graduate degree program.

Once being fully admitted to Mines, students will be required to fall under Mines degree requirements of the catalog in which they are first enrolled at Mines. Students that desire to complete the program in one year will be required to enroll in at least twenty four (24) credits (12 credits each semester) across the fall and spring semesters at Mines in order to complete the program in one year.

Course Requirements at Mines

These credit-hours must be from an approved list of courses. Students are advised to contact the Graduate Program Manager [or equivalent] of the Mineral and Energy Economics program regarding the specific terms and eligible courses for which this agreement applies.

Non-Thesis option

Core Courses

| | | |
|---------|---|-----|
| EBGN510 | NATURAL RESOURCE ECONOMICS (Fall) | 3.0 |
| EBGN509 | MATHEMATICAL ECONOMICS (Fall) | 3.0 |
| EBGN521 | MICROECONOMICS OF MINERAL AND ENERGY MARKETS (Spring) | 3.0 |
| EBGN590 | ECONOMETRICS I (Spring) | 3.0 |

Approved Electives

| | |
|---|-----------|
| Number depends upon 500-level credit transfers from CMU | 12.0-18.0 |
| CMU 400-level electives – at least two of three | 6.0-9.0 |

Total Semester Hrs **30-39**

Special Provision for recent CMU Alumni

In an effort to serve students who have previously graduated from CMU, Mines will allow students who have graduated from CMU Bachelor of Business Administration Energy Management/Landman since spring 2016 to participate.

Graduation

Students must complete all degree requirements as published in the Mines Graduate catalog.

V. Western Colorado University Combined Undergraduate / Graduate Degree Program

Please see Mines Registrar Transfer Agreements web page for detailed information.

The Colorado School of Mines shares a Memorandum of Understanding (MoU) with Western Colorado University. Through this program Colorado School of Mines (Mines) and Western Colorado University (Western), jointly provide opportunity to transition Western's Bachelor of Business Administration, Emphasis in Energy Management graduates to Mines in order to earn a MS Non-Thesis degree. This MoU grants students with the opportunity to apply up to six undergraduate-coursework credits applied to their Western degree towards their Mines graduate-degree requirements, while also waived graduate admissions application fee, waived requirement for three (3) letters of recommendation, and exemption from submitting GRE test scores.

Western students who successfully pass courses and meet the admission criteria of the program outlined below will be admitted to Mines at no

point before the student's senior year at Western. The student will be admitted to Mines as a Special Status graduate student. Upon successful completion of the undergraduate degree at Western and after meeting the Mines admission criteria, students will be admitted into the Mineral and Energy Economics MS Non-Thesis degree program and will be complete the MS Non-Thesis degree in two semesters.

Western Students must satisfy Mines Graduate Admissions requirements as specified in the Mines catalog in effect at the time the student's application. Students who meet the admission standards are guaranteed admission into the program. Students must also meet the following requirements:

- Students must apply for Graduate Admissions before the fall deadline and no earlier than before starting the final two semesters (senior year) at Western
- When applying, students must select the Western Combine Undergraduate/Graduate (4+1) program on the admissions application. Official Mines approval must be granted to Western students before the student is able to formally enter into program (4+1) agreement.
- Official approval and recommendation from Western Department Chair must be submitted at time of application.
- Official transcripts from Western must be submitted at the time of application to Mines and again after the undergraduate degree is conferred, but prior to the start of the term at Mines as a degree seeking student.
- The official final transcript must meet the minimum cumulative GPA that is required for admission to the Mines program. Completion of CMU Bachelor's Degree within 24 months of entering the 4+1 agreement is required.

Application procedures and deadlines

It is recommended that students talk to their Western Energy Management advisor or department chair and the Mines Mineral and Energy Economics program director about the admissions process from Western to Mines prior to the last two semesters of their undergraduate program. Admissions deadlines can be found online: www.Mines.edu/undergraduate-admissions/transfer-students/.

Tuition

Residency status for tuition purposes will be determined by what is provided on the admissions application. Refer to the Admissions website for residency information: <https://www.Mines.edu/graduate-admissions/>.

Enrollment Guidelines

Students will be expected to meet Western Bachelor of Business Administration, Emphasis in Energy Management graduation requirements. Other enrollment guidelines include the following:

Course Required

During the student's final two semesters at Western, students will complete at least two of these six 400 level courses at Western

| | | |
|---------|--------------------------------|-----|
| BUAD410 | WATER LAW OR ENVIRONMENTAL LAW | 3.0 |
| BUAD415 | PORTFOLIO MANAGEMENT | 3.0 |
| BUAD420 | OIL AND GAS LAW OR ENERGY LAW | 3.0 |
| BUAD421 | ENERGY CONTRACTS | 3.0 |
| BUAD460 | ADVANCED MANAGERIAL FINANCE | 3.0 |

| | | |
|---------|-----------------------------------|-----|
| BUAD495 | PROSPECT ECONOMICS AND EVALUATION | 3.0 |
|---------|-----------------------------------|-----|

Students must receive a grade of B or higher.

Students will be eligible to transfer six (6) credits of 500 or 600-level courses from Western (which were not used to meet any Western graduation requirement) to Mines per Mines transfer policy.

Any 500-level courses from Western

After completion of their Western Bachelor of Business Administration, Emphasis in Energy Management degree, students will be fully admitted into the Mineral and Energy Economics Mines Non-Thesis graduate degree program.

Once being fully admitted to Mines, students will be required to fall under Mines degree requirements of the catalog in which they are first enrolled at Mines. Students that desire to complete the program in one year will be required to enroll in at least twenty four (24) credits (12 credits each semester) across the fall and spring semesters at Mines in order to complete the program in one year.

Course Requirements at Mines

These credit-hours must be from an approved list of courses. Students are advised to contact the Graduate Program Manager [or equivalent] of the Mineral and Energy Economics program regarding the specific terms and eligible courses for which this agreement applies.

Non-thesis option

Core Courses

| | | |
|---------|---|-----|
| EBGN510 | NATURAL RESOURCE ECONOMICS (Fall) | 3.0 |
| EBGN509 | MATHEMATICAL ECONOMICS (Fall) | 3.0 |
| EBGN521 | MICROECONOMICS OF MINERAL AND ENERGY MARKETS (Spring) | 3.0 |
| EBGN590 | ECONOMETRICS I (Spring) | 3.0 |

Approved Electives

| | |
|---|-----------|
| Number depends upon 500-level credit transfers from Western | 12.0-18.0 |
| Western 400-level electives – at least two of six | 6.0-9.0 |

Total Semester Hrs **30-39**

Graduation

Students must complete all degree requirements as published in the Mines Graduate catalog.

VI. Dual Degree

The MS degree may be combined with a second degree from the IFP School (Paris, France) in Petroleum Economics and Management (see <http://www.ifp.fr>). This dual-degree program is geared to meet the needs of industry and government. Our unique program trains the next generation of technical, analytical and managerial professionals vital to the future of the petroleum and energy industries

These two world-class institutions offer a rigorous and challenging program in an international setting. The program gives a small elite group of students a solid economics foundation combined with quantitative business skills, the historical and institutional background, and the interpersonal and intercultural abilities to in the fast paced, global world of oil and gas.

Degrees: After studying in English for only 16 months (8 months at Mines and 8 months at IFP) the successful student of Petroleum Economics and Management (PEM) receives not 1 but 2 degrees:

- Masters of Science in Mineral and Energy Economics from Mines and
- Diplôme D'Ingénieur or Mastère Spécialisé from IFP

Important: Applications for admission to the joint degree program should be submitted for consideration by March 1st to begin the program the following fall semester in August. A limited number of students are selected for the program each year.

Prerequisites for the Mineral and Energy Economics Programs

Students must have completed the following undergraduate prerequisite courses prior to beginning the program with a grade of B or better:

1. Principles of Microeconomics;
2. One semester of college-level Calculus;
3. Probability and Statistics

Engineering and Technology Management (ETM) Master of Science Program Requirements

Students choose either the thesis or non-thesis option and complete a minimum of 30 credits. Initial admission is only to the non-thesis program. Admission to the thesis option requires subsequent application after admission to the ETM program.

Non-thesis option

| | |
|---------------------------|-------------|
| Core courses | 15.0 |
| Elective courses | 15.0 |
| Total Semester Hrs | 30.0 |

Thesis option

| | |
|---------------------------|-------------|
| Core courses | 15.0 |
| Research credits | 6.0 |
| Elective courses | 9.0 |
| Total Semester Hrs | 30.0 |

Students must receive approval from their advisor in order to apply non-EB Division courses towards their ETM degree. Thesis students are required to complete 6 credits of thesis credit and complete a Master's level thesis under the direct supervision of the student's thesis advisor.

Further Degree Requirements

All thesis and non-thesis ETM MS students have four additional degree requirements:

1. the Executive-in-Residence seminar series;
2. the ETM Communications workshop;
3. the Leadership and Team Building workshop;
4. Introductory Python Programming workshop.

All students are required to attend the ETM Program Executive-in-Residence seminar series during their first spring semester of study in the ETM Program. The Executive-in-Residence series features executives from industry who pass on insight and knowledge to graduate students preparing for positions in industry. This series facilitates

active involvement in the ETM program by industry executives through teaching, student advising activities and more. Every spring semester the Executive-in-Residence will present a number of seminars on a variety of topics related to leadership and strategy in the engineering and technology sectors.

In addition, all students in their first fall semester of study in the ETM Program are required to attend a Communications workshop, a Leadership and Team Building workshop and an Introductory Python Programming workshop. The Communications workshop will provide students with a comprehensive approach to good quality communication skills, including presentation proficiency, organizational skills, professional writing skills, meeting management, as well as other professional communication abilities. This workshop is designed to better prepare students for the ETM learning experience and their professional careers. The Leadership and Team Building workshop consists of non-competitive games, trust exercises and problem solving challenges and will introduce students to one another and provide opportunities to learn and practice leadership and team skills. Finally, the Python Programming workshop provides an introduction to using Python to solve analytical problems.

Mines' Combined Undergraduate/Graduate Degree Program

Students enrolled in Mines' combined undergraduate/graduate program may double count up to six credits towards the ETM degree under the following circumstances:

- (i) Any six credits of ETM graduate courses can be double counted.
- (ii) Any six credits of 400 level courses in the table below which are designated as graduate level classes for the purposes of the ETM degree.
- (iii) Any graduate course that has been approved by the ETM program committee as an ETM elective in a student's program of study.

These courses must have been passed with a "B" or better, not be substitutes for required coursework, and meet all other University,

| | | |
|---------|--|-----|
| MEGN485 | MANUFACTURING OPTIMIZATION WITH NETWORK MODELS | 3.0 |
| MEGN486 | LINEAR OPTIMIZATION | 3.0 |
| MEGN487 | NONLINEAR OPTIMIZATION | 3.0 |
| MEGN488 | INTEGER OPTIMIZATION | 3.0 |
| PEGN438 | PETROLEUM DATA ANALYTICS | 3.0 |

Transfer Credits

Students who enter the MS in Engineering and Technology Management program may transfer up to 6 graduate course credits into the degree program. The student must have achieved a grade of B or better in all graduate transfer courses and the transfer credit must be approved by the student's advisor and the Director of the ETM Program.

Required Curriculum MS Degree Engineering and Technology Management

Thesis and non-thesis students are required to complete the following 15 hours of core courses which ideally should be taken at the first available opportunity:

a. Core Courses

| | | |
|---------|--|-----|
| EBGN525 | BUSINESS ANALYTICS | 3.0 |
| EBGN540 | ACCOUNTING AND FINANCE | 3.0 |
| EBGN553 | PROJECT MANAGEMENT | 3.0 |
| EBGN563 | MANAGEMENT OF TECHNOLOGY AND INNOVATION | 3.0 |
| EBGN585 | ENGINEERING AND TECHNOLOGY MANAGEMENT CAPSTONE (to be taken during the final semester of coursework) | 3.0 |

Total Semester Hrs **15.0**

b. Elective courses (15 credits required for non-thesis option or 9 credits required for thesis option)

Engineering Management and Analytic Methods

| | | |
|---------|---|-----|
| EBGN526 | STOCHASTIC MODELS IN MANAGEMENT SCIENCE | 3.0 |
| EBGN528 | INDUSTRIAL SYSTEMS SIMULATION | 3.0 |
| EBGN555 | LINEAR PROGRAMMING | 3.0 |
| EBGN559 | SUPPLY CHAIN ANALYTICS | 3.0 |
| EBGN560 | DECISION ANALYTICS | 3.0 |
| EBGN571 | MARKETING ANALYTICS | 3.0 |

Technology Management and Innovation

| | | |
|---------|---|-----|
| EBGN562 | STRATEGIC DECISION MAKING | 3.0 |
| EBGN565 | MARKETING FOR TECHNOLOGY-BASED COMPANIES | 3.0 |
| EBGN566 | TECHNOLOGY ENTREPRENEURSHIP | 3.0 |
| EBGN572 | INTERNATIONAL BUSINESS STRATEGY | 3.0 |
| EBGN576 | MANAGING AND MARKETING NEW PRODUCT DEVELOPMENTS | 3.0 |
| EBGN577 | LEADING & MANAGING HIGH PERFORMING TEAMS | 3.0 |
| EBGN578 | BUSINESS OPERATIONS AND SUPPLY CHAIN MANAGEMENT | 3.0 |

Graduate Certificate in Resource Commodity Analytics

The graduate certificate requirements are to complete at least one course from the list of required courses, and nine additional credits either from the required courses list or the electives list. EBGN599 Independent study may satisfy no more than three credits of the certificate requirement. EBGN540 requires consent of instructor. Full-time students intending to complete the certificate in one semester must enter in the fall; part-time students can enter in the spring or fall.

Required courses (complete one of the following):

| | | |
|---------|----------------------------|-----|
| EBGN510 | NATURAL RESOURCE ECONOMICS | 3.0 |
| EBGN590 | ECONOMETRICS I | 3.0 |

Elective courses:

| | | |
|---------|---|-----|
| EBGN504 | ECONOMIC EVALUATION AND INVESTMENT DECISION METHODS | 3.0 |
| EBGN540 | ACCOUNTING AND FINANCE | 3.0 |
| EBGN560 | DECISION ANALYTICS | 3.0 |
| EBGN575 | ADVANCED MINING AND ENERGY ASSET VALUATION | 3.0 |
| EBGN594 | TIME-SERIES ECONOMETRICS | 3.0 |

| | | |
|---------|-------------------------|-----|
| EBGN632 | PRIMARY FUELS | 3.0 |
| EBGN645 | COMPUTATIONAL ECONOMICS | 3.0 |
| EBGN599 | INDEPENDENT STUDY | 3.0 |

Graduate Certificate in Business Analytics

The certificate is an online or residential program. The requirements are to complete the core course and two elective courses:

Core Course

| | | |
|---------|--------------------|-----|
| EBGN525 | BUSINESS ANALYTICS | 3.0 |
|---------|--------------------|-----|

Elective Courses

| | | |
|---------|------------------------|-----|
| EBGN559 | SUPPLY CHAIN ANALYTICS | 3.0 |
| EBGN560 | DECISION ANALYTICS | 3.0 |
| EBGN571 | MARKETING ANALYTICS | 3.0 |

Course substitutions may be approved on a case-by-case basis by the certificate director. Completing the certificate will also position students to apply to either the Master of Science in Engineering and Technology Management degree or the Master of Science in Data Science degree, as the certificate courses can be applied to either degree.

Graduate Certificate in Product Management

The certificate is an online or residential program. The requirements are to complete the core course and two elective courses:

Core Course

| | | |
|---------|---|-----|
| EBGN563 | MANAGEMENT OF TECHNOLOGY AND INNOVATION | 3.0 |
|---------|---|-----|

Elective Courses

| | | |
|---------|--|-----|
| EBGN553 | PROJECT MANAGEMENT | 3.0 |
| EBGN565 | MARKETING FOR TECHNOLOGY-BASED COMPANIES | 3.0 |
| EBGN577 | LEADING & MANAGING HIGH PERFORMING TEAMS | 3.0 |

Course substitutions may be approved on a case-by-case basis by the certificate director. Completing the certificate will also position students to complete the Master of Science in Engineering and Technology Management degree as all the certificate courses can be applied to this degree.

Courses

EBGN502. POLITICAL ECONOMY OF THE ENERGY TRANSITION. 3.0 Semester Hrs.

This course provides an overview of economics, business, and political topics that are commonly found in the energy transition. Many of the assignments relate back to skills that are needed to interact with economics, business, and policy professionals. The course is designed for students with little, if any, social science or business training. Students will build a basic knowledge of economics, finance, and business issues that are relevant to energy markets and industries.

EBGN504. ECONOMIC EVALUATION AND INVESTMENT DECISION METHODS. 3.0 Semester Hrs.

Time value of money concepts of present worth, future worth, annual worth, rate of return and break-even analysis are applied to after-tax economic analysis of mineral, petroleum and general investments. Related topics emphasize proper handling of (1) inflation and escalation, (2) leverage (borrowed money), (3) risk adjustment of analysis using expected value concepts, and (4) mutually exclusive alternative analysis and service producing alternatives. Case study analysis of a mineral or petroleum investment situation is required. Students may not take EBG504 for credit if they have completed EBG321.

EBGN509. MATHEMATICAL ECONOMICS. 3.0 Semester Hrs.

This course reviews and re-enforces the mathematical and computer tools that are necessary to earn a graduate degree in Mineral Economics. It includes topics from differential and integral calculus; probability and statistics; algebra and matrix algebra; difference equations; and linear, mathematical and dynamic programming. It shows how these tools are applied in an economic and business context with applications taken from the mineral and energy industries. It requires both analytical as well as computer solutions. At the end of the course you will be able to appreciate and apply mathematics for better personal, economic and business decision making. Prerequisites: Principles of Microeconomics, and MATH111.

EBGN510. NATURAL RESOURCE ECONOMICS. 3.0 Semester Hrs.

The threat and theory of resource exhaustion; commodity analysis and the problem of mineral market instability; cartels and the nature of mineral pricing; the environment; government involvement; mineral policy issues; and international mineral trade. This course is designed for entering students in mineral economics. Prerequisite: Principles of Microeconomics.

EBGN511. MICROECONOMICS. 3.0 Semester Hrs.

(I, II, S) This is a graduate course dealing with applied microeconomic theory. The course concentrates on the behavior of individual segments of the economy, the theory of consumer behavior and demand, duality, welfare measures, policy instruments, preferences over time and states of nature, and the fundamentals of game theory. Prerequisites: MATH111, EBG509. 3 hours lecture; 3 semester hours.

EBGN512. MACROECONOMICS. 3.0 Semester Hrs.

This course will provide an introduction to contemporary macroeconomic concepts and analysis. Macroeconomics is the study of the behavior of the economy as an aggregate. Topics include the equilibrium level of inflation, interest rates, unemployment and the growth in national income. The impact of government fiscal and monetary policy on these variables and the business cycle, with particular attention to the effects on the mineral industry. Prerequisites: Principles of Microeconomics, MATH111.

EBGN515. ECONOMICS AND DECISION MAKING. 3.0 Semester Hrs.

The application of microeconomic theory to business strategy. Understanding the horizontal, vertical, and product boundaries of the modern firm. A framework for analyzing the nature and extent of competition in a firm's dynamic business environment. Developing strategies for creating and sustaining competitive advantage.

EBGN521. MICROECONOMICS OF MINERAL AND ENERGY MARKETS. 3.0 Semester Hrs.

(I) This is a graduate course dealing with applied microeconomic theory. This course concentrates on the behavior of the minerals and energy segment of the economy, the theory of production and cost, the theory of consumer behavior and demand, derived demand, price and output level determination by firms, and the competitive structure of product and input markets. Prerequisites: MATH111, EBG509. 3 hours lecture; 3 semester hours.

EBGN523. MINERAL AND ENERGY POLICY. 3.0 Semester Hrs.

(II) An analysis of current topics in the news in mineral and energy issues through the lens of economics. Since many of the topics involve government policy, the course provides instruction related to the economic foundations of mineral and energy policy analysis. 3 credit hours.

EBGN525. BUSINESS ANALYTICS. 3.0 Semester Hrs.

The process of converting data into meaningful insights has become critical for organizations to stay competitive. Driven by the availability of massive volumes of business data, business analytics has become instrumental in informing managerial practices and strategies in companies at every stage of their operations. This course introduces fundamental concepts for descriptive analytics and statistical methods which provide primary skills to students that enable them to use quantitative tools for organizing, processing, and critically interpreting business data. Students will learn to use data analytics toolkits and libraries in Excel and Python to address real-world business problems in a variety of industries and disciplines, including energy, production, logistics, scheduling, marketing, and finance.

EBGN526. STOCHASTIC MODELS IN MANAGEMENT SCIENCE. 3.0 Semester Hrs.

(II) This course introduces the tools of stochastic modeling that are very useful in solving analytical problems in business. We cover methodologies that help to quantify the dynamic relationships of sequences of random events that evolve over time. Topics include static and dynamic Monte-Carlo simulation, discrete and continuous time Markov chains, probabilistic dynamic programming, Markov decision processes, queuing processes and networks, Brownian motion and stochastic control. Applications from a wide range of fields will be introduced including marketing, finance, production, logistics and distribution, energy and service systems. In addition to an intuitive understanding of analytical techniques to model stochastic processes, the course emphasizes how to use related software packages for managerial decision-making. 3 hours lecture; 3 semester hours.

EBGN527. BUSINESS OPTIMIZATION MODELS. 3.0 Semester Hrs.

Business optimization is one of the most important actions taken by businesses at the strategic, tactical, operational levels in order to stay competitive and successful. Prescriptive analytics aim to identify the optimal solutions for organizations. This course provides quantitative skills to solve real-world business problems using analytics by focusing on the art of model building using linear, integer and mixed-integer programming for business applications in several areas such as production, supply chain management, and finance. To this end, several real-world business problems will be examined. It also provides insights into specially structured models, and fundamental skills on model enhancement techniques. Prerequisite: Admission to the ETM program or permission of the instructor.

EBGN528. INDUSTRIAL SYSTEMS SIMULATION. 3.0 Semester Hrs.

The course focuses on creating computerized models of real or proposed complex systems for performance evaluation. Simulation provides a cost effective way of pre-testing proposed systems and answering "what-if" questions before incurring the expense of actual implementations. The course is instructed in the state-of-the-art computer lab (CTLM), where each student is equipped with a personal computer and interacts with the instructor during the lecture. Professional version of a widely used commercial software package, "Arena", is used to build models, analyze and interpret the results. Other business analysis and productivity tools that enhance the analysis capabilities of the simulation software are introduced to show how to search for optimal solutions within the simulation models. Both discrete-event and continuous simulation models are covered through extensive use of applications including call centers, various manufacturing operations, production/inventory systems, bulk-material handling and mining, port operations, high-way traffic systems and computer networks.

EBGN529. HEALTH SYSTEMS ENGINEERING ANALYTICS. 3.0 Semester Hrs.

This course provides skills on modeling and forecasting through the avenue of a hospital-wide learning system to develop, implement, and assess clinical operational excellence strategies for care delivery transformation across diverse health system settings. This course utilizes the science of improvement to understand and prioritize solutions to reduce flow failures and delays and achieve efficient hospital-wide patient flow, which is crucial for safe and quality care and effective utilization of healthcare resources. The emphasis is on the DMAIC problem-solving approach that drives Lean Six Sigma performance improvement project within the macro system dynamics. Prerequisite: None Co-requisite: None.

EBGN530. ECONOMICS OF INTERNATIONAL ENERGY MARKETS. 3.0 Semester Hrs.

Application of models to understand markets for oil, gas, coal, electricity, and renewable energy resources. Models, modeling techniques, and issues included are supply and demand, market structure, transportation models, game theory, futures markets, environmental issues, energy policy, energy regulation, input/output models, energy conservation, and dynamic optimization. The emphasis in the course is on the development of appropriate models and their application to current issues in energy markets. Prerequisites: Principles of Microeconomics, MATH111, EBG509, EBG510, EBG511.

EBGN535. ECONOMICS OF METAL INDUSTRIES AND MARKETS. 3.0 Semester Hrs.

(I, II, S) Metal supply from main product, byproduct, and secondary production. Metal demand and intensity of use analysis. Market organization and price formation. Public policy, comparative advantage, and international metal trade. Metals and economic development in the developing countries and former centrally planned economies. Environmental policy and mining and mineral processing. Students prepare and present a major research paper. Prerequisites: EBG201, MATH111, EBG509, and EBG510. 3 hours lecture; 3 semester hours.

EBGN536. MINERAL POLICIES AND INTERNATIONAL INVESTMENT. 3.0 Semester Hrs.

Identification and evaluation of international mineral investment policies and company responses using economic, business and legal concepts. Assessment of policy issues in light of stakeholder interests and needs. Theoretical issues are introduced and then applied to case studies, policy drafting, and negotiation exercises to assure both conceptual and practical understanding of the issues. Special attention is given to the formation of national policies and corporate decision making concerning fiscal regimes, project financing, environmental protection, land use and local community concerns and the content of exploration and extraction agreements. Prerequisites: Principles of Microeconomics, MATH111, EBG509, EBG510, EBG511.

EBGN537. ECONOMICS OF WATER. 3.0 Semester Hrs.

(II) This course seeks to develop the underlying economic logic of water use and how policy impacts the allocation of water in our economy. Water is a critical input for a number of sectors; from our basic sustenance to agriculture production, from industrial processes to ecological services, and from mineral extraction to energy production. Meanwhile, the supply of water is highly variable across space and through time while pollutants can further diminish the useable extent, making the policies to allocate and manage the resource central to understanding how the resource is utilized. The course will survey topics across sectors and water sources while applying economic theory and empirical/policy analysis. Prerequisite: EBG509 or MATH213 or GEGN580. 3 hours lecture; 3 semester hours.

EBGN540. ACCOUNTING AND FINANCE. 3.0 Semester Hrs.

(I) Included are the relevant theories associated with capital budgeting, financing decisions, and dividend policy. This course provides an in-depth study of the theory and practice of corporate accounting and financial management including a study of the firm's objectives, investment decisions, long-term financing decisions, and working capital management. Preparation and interpretation of financial statements and the use of this financial information in evaluation and control of the organization. 3 hours lecture; 3 semester hours.

EBGN541. INTERNATIONAL TRADE. 3.0 Semester Hrs.

Theories and evidence on international trade and development. Determinants of static and dynamic comparative advantage. The arguments for and against free trade. Economic development in nonindustrialized countries. Sectoral development policies and industrialization. The special problems and opportunities created by extensive mineral resource endowments. The impact of value-added processing and export diversification on development. Prerequisites: Principles of Microeconomics, MATH111, EBG509, EBG511.

EBGN542. ECONOMIC DEVELOPMENT. 3.0 Semester Hrs.

Role of energy and minerals in the development process. Sectoral policies and their links with macroeconomic policies. Special attention to issues of revenue stabilization, resource largesse effects, downstream processing, and diversification. Prerequisites: Principles of Microeconomics, MATH111, EBG509, EBG511, EBG512.

EBGN546. INVESTMENT AND PORTFOLIO MANAGEMENT. 3.0 Semester Hrs.

This course covers institutional information, valuation theory and empirical analysis of alternative financial investments, including stocks, bonds, mutual funds, ETS, and (to a limited extent) derivative securities. Special attention is paid to the role of commodities (esp. metals and energy products) as an alternative investment class. After an overview of time value of money and arbitrage and their application to the valuation of stocks and bonds, there is extensive treatment of optimal portfolio selection for risk averse investors, mean-variance efficient portfolio theory, index models, and equilibrium theories of asset pricing including the capital asset pricing model (CAPM) and arbitrage pricing theory (APT). Market efficiency is discussed, as are its implications for passive and active approaches to investment management. Investment management functions and policies, and portfolio performance evaluation are also considered. Prerequisites: Principles of Microeconomics, MATH111, MATH530.

EBGN547. FINANCIAL RISK MANAGEMENT. 3.0 Semester Hrs.

Analysis of the sources, causes and effects of risks associated with holding, operating and managing assets by individuals and organizations; evaluation of the need and importance of managing these risks; and discussion of the methods employed and the instruments utilized to achieve risk shifting objectives. The course concentrates on the use of derivative assets in the risk management process. These derivatives include futures, options, swaps, swaptions, caps, collars and floors. Exposure to market and credit risks will be explored and ways of handling them will be reviewed and critiqued through analysis of case studies from the mineral and energy industries. Prerequisites: Principles of Microeconomics, MATH111, MATH530, EBG505; EBG545 or EBG546. Recommended: EBG509, EBG511.

EBGN553. PROJECT MANAGEMENT. 3.0 Semester Hrs.

(I, II) Project management has evolved into a business process broadly used in organizations to accomplish goals and objectives through teams. This course covers the essential principles of traditional project management consistent with professional certification requirements (the Project Management Institute's PMP certification) as well as an introduction to current agile project management methodologies. The traditional project management phases of project initiation, planning, execution, monitoring and control, and project closure are covered including related scheduling, estimating, risk assessment and other analytical tools. Students will gain experience using Microsoft Project. Organizational structure and culture issues are analyzed to understand how they can impact project management success, and the concepts of project portfolios and project programs are applied from the organizational perspective. Agile project management methodologies are introduced, including adaptive and iterative processes, scrum, lean and other agile tools and techniques. By the end of the course, students will understand how traditional and agile project. 3 hours lecture; 3 semester hours.

EBGN555. LINEAR PROGRAMMING. 3.0 Semester Hrs.

This course addresses the formulation of linear programming models, examines linear programs in two dimensions, covers standard form and other basics essential to understanding the Simplex method, the Simplex method itself, duality theory, complementary slackness conditions, and sensitivity analysis. As time permits, multi-objective programming and stochastic programming are introduced. Applications of linear programming models discussed in this course include, but are not limited to, the areas of manufacturing, finance, energy, mining, transportation and logistics, and the military. 3 hours lecture; 3 semester hours.

EBGN559. SUPPLY CHAIN ANALYTICS. 3.0 Semester Hrs.

The focus of the course is to show how a firm can achieve better "supply-demand matching" through the implementation of rigorous mathematical models and various operational/tactical strategies. We look at organizations as entities that must match the supply of what they produce with the demand for their products. A considerable portion of the course is devoted to mathematical models that treat uncertainty in the supply-chain. Topics include managing economies of scale for functional products, managing market-mediation costs for innovative products, make-to order versus make-to-stock systems, quick response strategies, risk pooling strategies, supply-chain contracts and revenue management. Additional "special topics" may be introduced, such as reverse logistics issues in the supply-chain or contemporary operational and financial hedging strategies, as time permits.

EBGN560. DECISION ANALYTICS. 3.0 Semester Hrs.

Introduction to the science of decision making and risk theory. Application of decision analysis and utility theory to the analysis of strategic decision problems. Focuses on the application of quantitative methods to business problems characterized by risk and uncertainty. Choice problems such as decisions concerning major capital investments, corporate acquisitions, new product introductions, and choices among alternative technologies are conceptualized and structured using the concepts introduced in this course.

EBGN562. STRATEGIC DECISION MAKING. 3.0 Semester Hrs.

(I, II, S) This course covers how to unwind complex situations to gain clarity and enable confident decisions. The focus is on thinking as opposed to calculating, framing the problem correctly, ensuring clarity around the objectives, developing creative alternative strategies, and qualitatively evaluating these alternatives. Tools for accomplishing these goals will be introduced. Discussion topics include common psychological biases and traps, scenario analysis, game theory, cultural influences, and decision making in complex (as opposed to merely complicated) systems. 3 hours lecture; 3 semester hours.

EBGN563. MANAGEMENT OF TECHNOLOGY AND INNOVATION. 3.0 Semester Hrs.

Lectures, case studies and reading assignments explore strategies for profiting from technology assets and technological innovation. The roles of strategy, core competencies, product and process development, manufacturing, R&D, marketing, strategic partnerships, alliances, intellectual property, organizational architectures, leadership and politics are explored in the context of technological innovation. The critical role of organizational knowledge and learning in a firm's ability to leverage technological innovation to gain competitive advantage is explored. The relationships between an innovation, the competencies of the innovating firm, the ease of duplication of the innovation by outsiders, the nature of complementary assets needed to successfully commercialize an innovation and the appropriate strategy for commercializing the innovation are developed. Students explore the role of network effects in commercialization strategies, particularly with respect to standards wars aimed at establishing new dominant designs.

EBGN565. MARKETING FOR TECHNOLOGY-BASED COMPANIES. 3.0 Semester Hrs.

This class explores concepts and practices related to marketing in this unique, fast-paced environment, including the defining characteristics of high-technology industries; different types and patterns of innovations and their marketing implications; the need for (and difficulties in) adopting a customer-orientation; tools used to gather marketing research/intelligence in technology-driven industries; use of strategic alliances and partnerships in marketing technology; adaptations to the "4 P's"; regulatory and ethical considerations in technological arenas.

EBGN566. TECHNOLOGY ENTREPRENEURSHIP. 3.0 Semester Hrs.

Technology entrepreneurship is a distinct activity in technology enterprises and start-ups that require a disciplined approach to forming product concepts and justifying financial investment. This course covers technology categories, venture opportunity and strategy, product design, industry and competitive analysis, concept development, venture development, intellectual property, funding and financial projections. In addition, the course explores creativity, problem solving, business modeling, market analysis and business planning for technology-oriented solutions. A Venture Plan project will allow students to develop a start-up business concept with a technology product of their choosing. Venture Planning topics include: product design, product forecasting, revenue forecasting, operations planning, staffing plan, financial analysis, financial statements, funding sources and uses. A start-up venture plan will be created with 3-year projections for income statements, cashflow and balance sheet.

EBGN567. BUSINESS LAW AND ETHICS. 3.0 Semester Hrs.

(I) This course incorporates a broad range of legal topics and ethical issues relevant to technology-based organizations, from start-ups to mature Fortune 100 international corporations. The topics encompass numerous aspects of U.S. business law, including but not limited to: the U.S. court system, contracts, e-commerce, managerial ethics, white collar crimes, early stage business formation, intellectual property, product liability, agency law, employment law, mergers and acquisitions, antitrust, and unfair competition law. The course is discussion based, with some lecture, and is 3 semester credit hours. There are no prerequisites required for this course. A significant portion of class time will be applied to exploring and discussing assigned topics through relevant abbreviated court case descriptions, ethics reader assignments and current and recent events in global business. The overall goal of this course is not to make students legal experts but to make them better managers and leaders by equipping them with relevant legal. 3 hours lecture; 3 semester hours.

EBGN568. ADVANCED PROJECT ANALYSIS. 3.0 Semester Hrs.

An advanced course in economic analysis that will look at more complex issues associated with valuing investments and projects. Discussion will focus on development and application of concepts in after-tax environments and look at other criteria and their impact in the decision-making and valuation process. Applications to engineering and technology aspects will be discussed. Effective presentation of results will be an important component of the course. Prerequisite: EBG504.

EBGN570. ENVIRONMENTAL ECONOMICS. 3.0 Semester Hrs.

The role of markets and other economic considerations in controlling pollution; the effect of environmental policy on resource allocation incentives; the use of benefit/cost analysis in environmental policy decisions and the associated problems with measuring benefits and costs. Prerequisites: Principles of Microeconomics, MATH111, EBG509, EBG510.

EBGN571. MARKETING ANALYTICS. 3.0 Semester Hrs.

The purpose of this course is to gain an understanding of how data about customers and markets can be used to support and improve decision making. Using market data to evaluate alternatives and gain insight from past performance is the essence of marketing analytics. The course is focused on the marketing research decisions facing product managers in technology based companies and will appeal to students who want to gain a deeper understanding of such topics as the problems of target market selection, new product introductions, pricing, and customer retention. While the specifics of market analytics can vary across industries and firms, three main commonalities are: (1) defining the decision problem, (2) collection and analysis of high quality market data, and (3) implementing strategy through marketing mix decisions. In this course students will develop an understanding of available marketing analytic methods and the ability to use marketing research information to make strategic and tactical decisions.

EBGN572. INTERNATIONAL BUSINESS STRATEGY. 3.0 Semester Hrs.

The purpose of this course is to gain understanding of the complexities presented by managing businesses in an international environment. International business has grown rapidly in recent decades due to technological expansion, liberalization of government policies on trade and resource movements, development of institutions needed to support and facilitate international transactions, and increased global competition. Due to these factors, foreign countries increasingly are a source of both production and sales for domestic companies.

EBGN575. ADVANCED MINING AND ENERGY ASSET VALUATION. 3.0 Semester Hrs.

(I) The use of option pricing techniques in mineral and energy asset valuation. Mining and energy valuation standards and guidelines. Differentiation between static decision making, intertemporal decision making, and dynamic decision making under uncertainty. The comparison sales and cost approaches to valuation. Commodity price simulation and price forecasting. Risk-neutral valuation. Prerequisites: EBG504, EBG509, EBG510, EBG511, EBG521, EBG590. 3 hours lecture; 3 semester hours.

EBGN576. MANAGING AND MARKETING NEW PRODUCT DEVELOPMENTS. 3.0 Semester Hrs.

(II) This course provides a scientific approach to developing and marketing new products which are often critical to the success of firms competing in technology based industries. We will start with an overview of core marketing and then develop prototypes of a new product design. We will step through the new product development process in detail, learning about available tools and techniques to execute each process step along the way. New product prototypes will be used to gather data from prospective target markets and assess the viability of the design in the marketplace. 3 hours lecture; 3 semester hours.

EBGN577. LEADING & MANAGING HIGH PERFORMING TEAMS. 3.0 Semester Hrs.

(I) Effective leaders contribute significantly to their organization's performance. When they take advantage of a technological innovation or respond to a crisis, leaders rely on critical skills to communicate their vision and coordinate tasks performed by others. This course is about developing your unique leadership skills and style whether you lead a small engineering team or, eventually, a large global corporation. We review key theories of leadership and examine the lessons learned from those who applied them. We synthesize and translate these lessons into specific behaviors that enhance your ability to lead. We discuss how generational shifts, economic and political factors impact the workplace in ways that call for effective, quality leadership. Ultimately, you have to understand how to lead and motivate individuals who don't look or think like you. This may involve motivating followers and involving them in making decisions. Following a learning-by-doing approach, we complement class discussions and case studies with a hands-on simulation of a leadership team facing a series of crises.

EBGN578. BUSINESS OPERATIONS AND SUPPLY CHAIN MANAGEMENT. 3.0 Semester Hrs.

Business Operations and Supply Chain Management is an elective course for ETM, approved masters and undergrad students who wish to learn how businesses operations support the business strategy. This course focuses on business operations for manufacturing and service industries, as well as Supply Chain Management. Students will gain an understanding of the businesses that they will shortly be involved with as they start their first career positions. Hands-on exercises to learn how to design processes, trouble shoot operational problems with root cause analysis, prepare business case studies, and conduct process simulations during the course. Key Business Operations topics include: operations strategy and objectives, product design, manufacturing production types, Lean Manufacturing, distribution, process design, productivity, optimization, control system theory, quality control, Total Quality Management (TQM), forecasting, and Six Sigma. Key Supply Chain Management topics include: capacity and demand planning, inventory management, distribution strategies, supplier risk mitigation and global supply chain management.

EBGN580. EXPLORATION ECONOMICS. 3.0 Semester Hrs.

Exploration planning and decision making for oil and gas, and metallic minerals. Risk analysis. Historical trends in exploration activity and productivity. Prerequisites: EENG480 or instructor consent.

EBGN585. ENGINEERING AND TECHNOLOGY MANAGEMENT CAPSTONE. 3.0 Semester Hrs.

This course represents the culmination of the ETM Program. This course is about the strategic management process ? how strategies are developed and implemented in organizations. It examines senior management's role in formulating strategy and the role that all an organization's managers play in implementing a well thought out strategy. Among the topics discussed in this course are (1) how different industry conditions support different types of strategies; (2) how industry conditions change and the implication of those changes for strategic management; and (3) how organizations develop and maintain capabilities that lead to sustained competitive advantage. This course consists of learning fundamental concepts associated with strategic management process and competing in a web-based strategic management simulation to support the knowledge that you have developed.

EBGN590. ECONOMETRICS I. 3.0 Semester Hrs.

(II) This course covers the statistical methods used by economists to estimate economic relationships and empirically test economic theories. Topics covered include hypothesis testing, ordinary least squares, specification error, serial correlations, heteroskedasticity, qualitative and limited dependent variables, time series analysis and panel data. Prerequisites: MATH111, MATH530, EBG509. 3 hours lecture and discussion; 3 semester hours.

EBGN594. TIME-SERIES ECONOMETRICS. 3.0 Semester Hrs.

(II) This is a course in applied time-series econometrics. It covers contemporary approaches for interpreting and analyzing time-series economic data. Hypothesis testing and forecasting both receive attention. Topics include stochastic difference equations, applied forecasting, stationary univariate models, models with constant and time-varying variance, deterministic and stochastic trend models and associated unit root and structural break tests, as well as single-equation and multiple-equation time-series models that include error-correction techniques and cointegration tests. 3 hours lecture; 3 semester hours.

EBGN598. SPECIAL TOPICS IN ECONOMICS AND BUSINESS. 6.0 Semester Hrs.

(I, II, S) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once, but no more than twice for the same course content. Prerequisite: none. Variable credit: 0 to 6 credit hours. Repeatable for credit under different titles.

EBGN599. INDEPENDENT STUDY. 0.5-6 Semester Hr.

(I, II, S) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: ?Independent Study? form must be completed and submitted to the Registrar. Variable credit: 0.5 to 6 credit hours. Repeatable for credit under different topics/ experience and maximums vary by department. Contact the Department for credit limits toward the degree.

EBGN610. ADVANCED NATURAL RESOURCE ECONOMICS. 3.0 Semester Hrs.

Optimal resource use in a dynamic context using mathematical programming, optimal control theory and game theory. Constrained optimization techniques are used to evaluate the impact of capital constraints, exploration activity and environmental regulations. Offered when student demand is sufficient. Prerequisites: Principles of Microeconomics, MATH111, MATH5301, EBG509, EBG510, EBG511.

EBGN611. ADVANCED MICROECONOMICS. 3.0 Semester Hrs.

A second graduate course in microeconomics, emphasizing state-of-the-art theoretical and mathematical developments. Topics include consumer theory, production theory and the use of game theoretic and dynamic optimization tools. Prerequisites: Principles of Microeconomics, MATH111, MATH5301, EBG509, EBG511.

EBGN632. PRIMARY FUELS. 3.0 Semester Hrs.

(II) Application of models to understand markets for oil, gas, coal exploration and extraction. Empirical, theoretical and quantitative models and modeling techniques are stressed. The issues included are identification of cause and effect, market structure, game theory, futures markets, environmental issues, energy policy, energy regulation. The emphasis in the course is on the development of appropriate models and their application to current issues in primary fuel/upstream markets. Prerequisites: EBG590. 3 hours lecture; 3 semester hours.

EBGN645. COMPUTATIONAL ECONOMICS. 3.0 Semester Hrs.

(II) This course is about learning the skills required to construct and manipulate numerical models as an instrument of economic research. In the first part of the course, students will learn about basic classes of optimization problems as ways to operationalize models of equilibrium behavior from economics and how to formulate and solve these problems on the computer. In the second part of the course, students will focus on the techniques used specifically in computable general equilibrium (CGE) analysis and developing applications of CGE models to topics in energy, environmental and natural resource economics. Prerequisites: MATH111, MATH530, Principles of Microeconomics, EBG509, EBG511. 3 hours lecture; 3 semester hours.

EBGN655. ADVANCED LINEAR PROGRAMMING. 3.0 Semester Hrs.

Equivalent with EBG650,

As an advanced course in optimization, this course will expand upon topics in linear programming. Specific topics to be covered include advanced formulation, column generation, interior point method, stochastic optimization, and numerical stability in linear programming. Applications of state-of-the-art hardware and software will emphasize solving real-world problems in areas such as mining, energy, transportation and the military. Prerequisites: EBG555. 3 hours lecture; 3 semester hours.

EBGN690. ECONOMETRICS II. 3.0 Semester Hrs.

A second course in econometrics. Compared to EBG590, this course provides a more theoretical and mathematical understanding of econometrics. Matrix algebra is used and model construction and hypothesis testing are emphasized rather than forecasting. Prerequisites: Principles of Microeconomics, MATH111, MATH530, EBG509, EBG590. Recommended: EBG511.

EBGN695. RESEARCH METHODOLOGY. 3.0 Semester Hrs.

Lectures provide an overview of methods used in economic research relating to EPP and QBA/OR dissertations in Mineral Economics and information on how to carry out research and present research results. Students will be required to write and present a research paper that will be submitted for publication. It is expected that this paper will lead to a Ph.D. dissertation proposal. It is a good idea for students to start thinking about potential dissertation topic areas as they study for their qualifier. This course is also recommended for students writing Master's thesis or who want guidance in doing independent research relating to the economics and business aspects of energy, minerals and related environmental and technological topics. Prerequisites: MATH530, EBG509, EBG510, EBG511, EBG590.

EBGN698. SPECIAL TOPICS IN ECONOMICS AND BUSINESS. 6.0 Semester Hrs.

(I, II, S) Pilot course or special topics course. Topics chosen from special interests of instructor(s) and student(s). Usually the course is offered only once, but no more than twice for the same course content. Prerequisite: none. Variable credit: 0 to 6 credit hours. Repeatable for credit under different titles.

EBGN699. INDEPENDENT STUDY. 0.5-6 Semester Hr.

(I, II, S) Individual research or special problem projects supervised by a faculty member, also, when a student and instructor agree on a subject matter, content, and credit hours. Prerequisite: Independent Study form must be completed and submitted to the Registrar. Variable credit: 0.5 to 6 credit hours. Repeatable for credit under different topics/experience and maximums vary by department. Contact the Department for credit limits toward the degree.

EBGN707. GRADUATE THESIS / DISSERTATION RESEARCH CREDIT. 1-15 Semester Hr.

(I, II, S) Research credit hours required for completion of a Masters-level thesis or Doctoral dissertation. Research must be carried out under the direct supervision of the student's faculty advisor. Variable class and semester hours. Repeatable for credit.

Professor

Jared C. Carbone

Research Professor

Roderick G. Eggert

Associate Professors

Ian Lange

Qiaohai (Joice) Hu

Assistant Professors

Benjamin Gilbert

Steven M. Smith

Teaching Professors

Scott Houser, Department Head

Becky Lafrancois

Teaching Associate Professors

Crystal Dobratz

Andrew Pederson

Teaching Assistant Professor

Mona Jabbari

Professor of Practice

David Culbreth

Patrick Leach

Paul Zink

Professors Emeriti

Carol A. Dahl

Graham Davis

Franklin J. Stermole

John E. Tilton

Michael R. Walls