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 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 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 MS 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 MS degree in Mineral and Energy Economics or Engineering and Technology Management while completing their bachelor's degree at Mines. For more information please contact the EB Office or visit https://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 and regulation, data analysis and 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.

Primary Contact

Economics and Business Department
https://econbus.mines.edu/

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 in the Mineral and Energy Economics Program, students 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.

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 An alternative econometrics elective may be substituted for EBGN594	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 9-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 coursework, 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 An alternative econometrics elective may be substituted for EBGN594	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 9-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. EBGN509, EBGN510, and EBGN521 in the first fall semester of study and EBGN590 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 events that prevent 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 the Mines Registrar Transfer Agreements webpage for detailed information.

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 graduate coursework credits from their Colorado Mesa University degree toward their Mines graduate-degree requirements, while also waiving graduate admissions application fee, requirement for three letters of recommendation, and exempting 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:

a. Students must apply for graduate admissions before the fall deadline and no earlier than before starting the final two semesters (senior year) at CMU
b. 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.
c. Official approval and recommendation from CMU department chair must be submitted at time of application.
d. 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.
e. 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 at https://mines.edu/undergraduate-admissions/.

Tuition

Residency status for tuition purposes will be determined by what is provided on the admissions application.

Enrollment Guidelines

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

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

Students must receive a grade of B or higher.

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 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
Total Semester Hrs		**24-30**

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 the Mines Registrar Transfer Agreements webpage for detailed information.

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 6 graduate coursework credits applied from their Western degree toward their Mines graduate-degree requirements, while also waiving the graduate admissions application fee, requirement for three letters of recommendation, and exempting 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:

a. Students must apply for graduate admissions before the fall deadline and no earlier than before starting the final two semesters (senior year) at Western.
b. 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.
c. Official approval and recommendation from Western department chair must be submitted at time of application.
d. 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.
e. 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 at https://mines.edu/undergraduate-admissions/.

Tuition

Residency status for tuition purposes will be determined by what is provided on the admissions application. Refer to the Admissions webpage for residency information at 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 graduate level courses at Western
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
Students must receive a grade of B or higher.

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 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
Total Semester Hrs		**24-30**

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 https://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 succeed in the fast-paced, global world of oil and gas.

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

- Master 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 toward 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 6 credits toward the ETM degree under the following circumstances:

(i) Any 6 credits of ETM graduate courses can be double counted.
(ii) 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,

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
EBGN527	BUSINESS OPTIMIZATION MODELS	3.0
EBGN528	INDUSTRIAL SYSTEMS SIMULATION	3.0
EBGN529	HEALTH SYSTEMS ENGINEERING ANALYTICS	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 9 additional credits either from the required courses list or the electives list. EBGN599 independent study may satisfy no more than 3 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

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

- 1. Interpret and assess basic economic intuition and lingo so that one can contribute to projects on the business side
- 2. Evaluate and critique standard investment analysis techniques
- 3. Describe common market structures for natural resource commodities and theorize its impact on firm behavior
- 4. Name the location of basic data on energy price, production, and consumption and demonstrate its evolution over time
- 5. Analyze the politics behind an aspect of the energy transition
- 6. Identify key political actors in the transition
- 7. Design a presentation for the business community that provides a clear value proposition.
- 8. Execute an "elevator pitch" (concise and persuasive speech to spark interest) about an energy/natural resource topic.

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 EBGN504 for credit if they have completed EBGN321.

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, EBGN509. 3 hours lecture; 3 semester hours.
Course Learning Outcomes

- No change

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, EBGN509. 3 hours lecture; 3 semester hours.
Course Learning Outcomes

- No change

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.
Course Learning Outcomes

- Understand the basics of probability theory
- Gain skills in cleaning raw business data by imputing missing cells, identifying and handling outliers, eliminating unnecessary attributes using Excel
- Explore, visualize and critically interpret business data using Python
- Understand and perform linear regression analysis and interpret the results using tools in Python
- Address real-world business problems in a variety of disciplines using analytical thinking skills in cleaning, processing and analyzing raw business data and converting them into meaningful managerial insights

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.
Course Learning Outcomes

- Explain the basics of probability theory.
- Use conditional probability and expectations in real-world problems.
- Explain and model systems by applying Markov Chains to stochastic processes in discrete and continuous time.
- Explain and apply Poisson processes to solve problems involving random events occurring over time.
- Utilize transition probability matrices to determine the long-term behavior of Markov chains.
- Apply basic principles of queueing theory and models to analyze the performance of complex service systems.

- Implement simulation techniques to explore the behavior stochastic systems and interpret the results.

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.
Course Learning Outcomes

- Develop a high-level understanding of what prescriptive analytics is and its difference from descriptive and predictive analytics.
- Develop skills on the art of formulating deterministic optimization models for business problems.
- Develop insights into specially structured models that provide skills in identifying and using them in business applications.
- Identify objectives, limitations and necessary inputs for business problems.
- Develop optimization models for business problems and solve them to obtain optimal decisions using AMPL with different solvers (e.g., CPLEX, GUROBI).
- Gain skills in model enhancement techniques to develop efficient optimization models.
- Develop skills in analyzing the optimal solution and extracting insights from it.

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.
Course Learning Outcomes

- Identify appropriate systems for simulation modeling.
- Use probability models to determine the probability or expectation of events.
- Build single-queue single-server queuing models and provide steady-state, long-run performance values.
- Model and build basic simulations using an Excel spreadsheet.
- Model and build more complex simulations using Arena.
- Select reasonable probability distributions for predicting future events.
- Analyze simulation output to drive system evaluation and decisions.
- Model a real or proposed system as a simulation project and make recommendations based on the results.

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.
Course Learning Outcomes

- Learning Outcome 1 (LO1): 'D' Define
- Learning Outcome 2 (LO2): 'M' Measure
- Learning Outcome 3 (LO3): 'A' Analyze
- Learning Outcome 4 (LO4): 'I' Improve
- Learning Outcome 5 (LO5): 'C' Control

EBGN530. ECONOMICS OF INTERNATIONAL ENERGY MARKETS. 3.0 Semester Hrs.
With the global energy transition to a low carbon future in full swing, understanding and shaping energy outcomes in an international context is as important as ever. This course equips students with foundational economic analytical tools and techniques to enhance such understanding and help make economic policy recommendations to achieve the socially desired outcomes. Students will apply economic models to understand markets for fossil fuels, electricity, and renewable energy resources. Models, modeling techniques, and applications include energy market structure and trading; energy efficiency and project analysis; energy taxes and subsidies, energy policy and regulation; risk management with futures and options; and evaluating energy-economy interactions. International databases will be introduced in support of data-based modeling and policy analysis. Given the interdisciplinary nature of energy markets other disciplines will be touched upon including cutting edge energy technologies, energy geopolitics, as well as softer topics such as environmental, social, and governance (ESG) issues, international and intercultural management, and social justice. 3 hours lecture; 3 semester hours. Prerequisites: Math111, Principles of Microeconomics recommended.
Course Learning Outcomes

- Identify and list major properties of key energy sources: coal, oil, natural gas, electricity, and renewable energy, know definitions of the key energy concepts and policies provided within each chapter.
- Make conversions using metric/non-metric rates, price indices, and exchange rates
- Use the international databases provided to the class to identify, graph, discuss, and measure energy trends, growth rates, correlations between variables, and large market players and complete assigned tasks to help maintain and enhance the collection of databases
- Review and apply the models and tools in microeconomics (market models), calculus (optimization, derivatives, integrals), and probability

and statistics (means, variances, correlations, expected values) to specific energy examples.
- Apply qualitative models to show and explain the effects that causal variables have on energy markets
- Build and solve quantitative models with manual solutions for simple examples and computer applications (Excel and Gams) for more complicated models and to check manual solutions.
- Recognize how, what, when, and where models can be used for forecasting, policy analysis, project evaluation, economic decision-making, and analyzing current events and controversies relating to energy markets.
- Develop critical thinking skills to identify energy economic myths or misconception from the popular press or internet and be able to use concepts from the course to explain why they are misleading or wrong.

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: EBGN201, MATH111, EBGN509, and EBGN510. 3 hours lecture; 3 semester hours.
Course Learning Outcomes

- Same as before

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, EBGN509, EBGN510, EBGN511.

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: EBGN509 or MATH213 or GEGN580. 3 hours lecture; 3 semester hours.
Course Learning Outcomes

- 1. Economic modelling of water systems
- 2. Empirical assessment of water policies
- 3. Valuation techniques for water resources
- 4. How institutional structure effect development
- 5. Economic tools to assess water allocation and water pollution
- 6. Application to specific sectors

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.
Course Learning Outcomes

- Evaluate financial performance, financial position, and prospects in terms of financial risk, liquidity, solvency, efficiency, company profitability, growth outlook and comparisons to other companies.
- Interpret financial statements and determine how they reflect operating results.
- Allocate capital optimally by selecting the most attractive investments using time value of money principles, discounted cash flow and appropriate risk-return measures.
- Evaluate financial results from the viewpoint of various stakeholders (investors, suppliers, lenders, etc.) by looking at what's most important from their various perspectives.
- Predict the impact of management decisions on key financial measures that include profitability, efficiency, capital needs, cost structure, etc.
- Calculate the true economic value added for a given company, based on financial results.
- Estimate cost of debt, cost of equity and weighted average costs of capital (WACC) and evaluate default risk to determine the best way for a company to raise financing.
- Build financial models to value assets, evaluate capital investment alternatives and forecast capital needs.

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, EBGN509, EBGN511.

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, EBGN509, EBGN511, EBGN512.

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, EBGN505; EBGN545 or EBGN546. Recommended: EBGN509, EBGN511.

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.
Course Learning Outcomes

- Create a work breakdown structure and estimate for a proposed project using an Excel spreadsheet.
- Manage the multiple constraints of a technology development project using a project management project or challenging scenarios in a project management simulation game.
- Judge the opportunities and challenges of high-performance teams, including leadership skills and personnel management through case studies and in class discussions.
- Investigate the roles and responsibilities of a Project Manager and stakeholders using a RACI chart in an in-class exercise.
- Define the tools and techniques for small, medium and large projects in exercises and a Mid-Term exam.
- Identify project management techniques that were successful or failures using case studies and class discussions.
- Define a basic project risk assessment with impact and probability using exercises.
- Assess Agile project management and how it differs from traditional project management through class lectures.
- Manage a project from start to finish including problem-solving and management recommendations based on quantitative analysis.
- Apply presentation, leadership and group management skills to provide a professional proposal and presentation of an approved team project.

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.
Course Learning Outcomes

- Apply probability concepts to analyze uncertainties in supply chain scenarios.
- Implement demand forecasting techniques to predict future inventory needs in various supply chain contexts.
- Utilize inventory theory and models, such as EOQ and newsvendor, to determine optimal inventory levels.
- Formulate the facility location problems, traveling salesman problem, and vehicle routing problem to analyze and improve the supply chain networks and determine efficient routes and logistics performance.
- Identify assumptions of each model and their implications.
- Construct a model based on explicit assumptions and explain the findings/results.

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.
Course Learning Outcomes

- Build an economic cashflow model in Excel and derive insights from the results.

- Create an Influence Diagram to represent the relationships between uncertainties and decisions in a given business situation.
- Design a decision tree model using Precision Tree software, modeling the situation faced by a company in a case study and generating a recommended course of action based on mean Net Present Value.
- Design a Monte Carlo simulation model using @Risk software, modeling the situation faced by a company in a case study and calculating common financial metrics (NPV, IRR, capital efficiency), and generate a recommended course of action based on the results from that model.
- Formulate a Value-of-Information (VOI) analysis to recommend a decision regarding whether a company should pay a specific amount for a given piece of information.
- Derive valid P10, P50, and P90 inputs (10th, 50th, and 90th percentiles, respectively) for a probabilistic model by conducting Subject-Matter-Expert (SME) interviews for specific uncertainties in a way that mitigates known human biases (both cognitive and motivational). Valid model outputs cannot be generated without valid inputs.
- Develop an approach to applying one's risk tolerance at the portfolio level.
- Compare and contrast applying one's risk tolerance at the portfolio level with applying one's risk tolerance at the individual project level, in terms understandable to someone with little to no background in business or statistics.

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.
Course Learning Outcomes

- Design a good decision-making process for complex problems.
- Derive different types of key issues from difficult situations and manage them effectively.
- Develop methods and tools to characterize uncertainty appropriately in decision making.
- Create objective hierarchies.
- Generate creative alternative strategies.
- Modify the decision process to avoid and mitigate the pitfalls that comes from human psychological weaknesses.
- Develop effective solutions to both complicated and complex problems.

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.
Course Learning Outcomes

- Analyze key theories and models of technological innovation and their relevance to various industry contexts using readings and quizzes.
- Evaluate the impact of innovation on competitive advantage and business success in technology-intensive sectors through case study discussions.
- Develop successful and unsuccessful approaches to technology commercialization using strategic management tools in case study discussions.
- Design effective strategies to foster and manage innovation in both startups and established firms.
- Distinguish the role of intellectual property in shaping technological innovation through guest speaker presentations.
- Create a management recommendations final paper based on analysis of an innovative company through effective team collaboration, demonstrating leadership and problem-solving skills.

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.
Course Learning Outcomes

- Differentiate characteristics of high-technology industries versus stable industries as presented in course readings through class discussions and exams/quizzes.
- Examine patterns of innovation, and their marketing implications, within high-technology environments through class discussions, case analyses, and exams.
- Develop a customer-orientation from a high-technology environment through class discussions, case analyses, and the project.
- Assemble marketing data that guides research intelligence in technology-driven industries through class discussions, case analyses, and the project.
- Formulate the appropriate marketing mix required in a high-tech environment through case analyses and the project write-up and presentation.
- Examine the dynamics of specific high-tech companies that are based on real-life case studies through class discussions and the project.
- Select best practices for marketing efforts within high-tech companies that are based on real-life scenarios through class discussions, journal entries, and the project.

- Assemble a rigorous marketing plan with teammates based on market analysis for a high-tech industry and feedback from class discussions that can be presented as a written report and a presentation.

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.
Course Learning Outcomes

- Develop a technology innovator and leader self-assessment based on strengths, goals and themes for innovation.
- Evaluate the impact of critical driving forces on the success of new ventures through analysis of case studies and technology startups using in-class discussions.
- Summarize the strategies used by investors to find and assess durable opportunities in technology entrepreneurship using the five investment factors.
- Conduct industry, market and competitive analysis of an existing start-up company in a written 5-8 page research paper.
- Create a potential small-scale solution to a plastic waste problem using the problem-solving process in a written 4-6 page paper.
- Develop a prototype of a technology product that demonstrates the application of Design Thinking to achieve a balance between aesthetic appeal and practical functionality.
- Create a comprehensive start-up Venture Plan that includes detailed financial projections and proforma financial tables.

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. He 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.
Course Learning Outcomes

- At the conclusion of this course students will be able to: 1. Describe the sources of U.S. law and explain the differences between law, ethics and the social responsibility of business. 2. Integrate business law considerations into business decision processes, and demonstrate how this integration can identify important questions that must be considered from a risk context. 3. Gain business skills by exercising advocacy of alternative positions in class and online discussions. 4. Analyze business cases to identify legal and ethical considerations. 5. Demonstrate how ethical issues and considerations can impact personal and managerial decisions in business organizations. 6. Define the structure of the U.S. court system, the general stages of the civil litigation process and forms of alternative dispute resolution available to commercial enterprises. 7. Apply the elements of contract formation, performance and discharge to commercial transaction scenarios to identify potential contractual legal risks and liabilities. 8. Analyze contract breach scenarios and determine damages calculations and possible equitable remedies. 9. Identify business and white-collar crimes, and describe the U.S. criminal legal procedure. 10. Define intentional and unintentional torts that can apply to business conduct, and identify activities that could expose an organization to risks of legal liability under the legal theories of negligence. 11. Describe the different forms of intellectual property protection, including patents, trademarks, copyrights and trade secrets and how they may apply to different forms of technology development. 12. Identify express and implied warranties, and define the sources of product liability. 13. Define the different types of bankruptcy available under federal law, and describe federal bankruptcy procedure. 14. Apply agency law to different employment and agency business situations to identify potential legal risks and obligations. 15. Analyze an entrepreneurial business opportunity and identify the available forms of legal entity creation applicable to those opportunities. 16. Explain the elements of good corporate governance. 17. Define three different forms of business mergers and acquisitions, and how the general antitrust laws can impact potential business combinations. 18. Identify at least three labor and employment practices that can expose businesses to legal liability.

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: EBGN504.

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, EBGN509, EBGN510.

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.

Course Learning Outcomes

- Define the decision problem and determine what information is needed.
- Acquire trustworthy and relevant data and judge its quality.
- Develop an understanding of key modeling techniques.
- Utilize a modeling approach to be able to make certain types of marketing 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: EBGN504, EBGN509, EBGN510, EBGN511, EBGN521, EBGN590. 3 hours lecture; 3 semester hours.

Course Learning Outcomes

- n/a

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.

Course Learning Outcomes

- Use nimble processes to develop a new offering.
- Leverage your organization's resources, capabilities and technical opportunites.
- Formulate a vision for your proposed offering.
- Strategically segment and target the most promising beneficiaries.
- Gather, analyze and operationalize target segment(s) unmet needs and wants.
- Develop an innovative business model to ensure the new offering achieves its strategic objectives.
- Efficiently validate assumptions, features and customer acceptance of proposed offering.
- Create a plan to pilot your proposed offering and explore partnerships.
- Create an effective launch model/plan to maximize initial adoption of your proposed offering.

EBGN577. LEADING AND 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.

Course Learning Outcomes

- Articulate a vision of effective leadership that is refined across the course through participation in simulations, reflections and discussions.
- Assess the value of collaborative relationships, conflict resolution and human capital via case study analysis and discussions.
- Develop awareness of your leadership skills through individual and team leadership and personality assessments.
- Apply individual leadership skills in the context of organizational change through a variety of individual and team assessments, along with group discussions and simulations.
- Develop a plan based on best practices in effective leadership for organizational change to address the needs and challenges as identified in simulations.
- Distinguish between the roles of leaders versus managers within various case studies and course readings.
- Develop viable solutions that influence, motivate, and empower others through case study analysis and discussions.
- Analyze leadership styles and the necessary organizational conditions to foster team success using a variety of frameworks.

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.

Course Learning Outcomes

- Design a dual-cycle value chain for a restaurant business with a diagram and 2-3 page report.
- Understand a variety of value-adding business models and their associated operations.
- Evaluate the impact of critical driving forces on the business' operations and supply chains through analysis and class discussions of case studies of technology startups.
- Define the business, sales and production strategies for an existing corporation in a 4-6 page paper.
- Create a detailed process flow diagram of value chain based on a real-world business operation.
- Analyze a quality control system using statistical process control through case studies and 3 homework quizzes.
- Validate organizational efficiency improvement measures, such as Control Systems, Total Quality Management, Six Sigma, Lean Manufacturing, and Sales Forecasting through a Mid-Term exam.
- Define the fundamental concepts and strategies of supply chain management through reading assignments and 3 homework quizzes.
- Manage a multi-tiered supply chain in a group of four students using two simulation games.

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. It addresses the question of 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 extending to project development and competing in simulation(s) to support the knowledge that have been developed.

Course Learning Outcomes

- Assess a given firm's resources and potential sources of competitive advantage within a variety of industries through case/simulation analysis and projects.
- Deduce the underlying problems in a complex business scenario through various assessments..
- Articulate the type of, and difference between, business-level strategies and corporate-level strategies through class/team discussions and quizzes.
- Create strategic options that a particular firm could pursue based on the analysis of the internal and external environment through case/simulation analysis and projects.
- Deconstruct a firm's potential business or corporate-level strategies down to the tactical level for implementation.
- Predict appropriate strategic outcomes for a given company using an evaluation of the internal and external environments through case/simulation analysis and projects.
- Experiment with implementing tactical choices that influence a firm's success rate.
- Reflect on previous performance results within various scenarios to see the best tactical choices to implement moving forward.

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, EBGN509. 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.

Course Learning Outcomes

- No changes

EBGN598. SPECIAL TOPICS IN ECONOMICS AND BUSINESS. 0-6 Semester Hr.
(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.

EBGN598. SPECIAL TOPICS IN ECONOMICS AND BUSINESS. 0-6 Semester Hr.

EBGN598. SPECIAL TOPICS. 0-6 Semester Hr.

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.

EBGN599. INDEPENDENT STUDY. 0.5-6 Semester Hr.

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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, EBGN509, EBGN510, EBGN511.

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, EBGN509, EBGN511.

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: EBGN590. 3 hours lecture; 3 semester hours.
Course Learning Outcomes

- 1. Rigorous identification of issues affecting coal, oil and gas extraction
- 2. Market structure effects on production
- 3. The impact of policies on production and investment
- 4. Where to find basic data on energy supply and investment
- 5. How to organize basic information in a paper/presentation
- 6. How to write/present your thoughts in a clear and concise manner

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, EBGN509, EBGN511. 3 hours lecture; 3 semester hours.
Course Learning Outcomes

- Understand basic classes of mathematical programming problems.
- Formulate and solve economic models on the computer.
- Calibrate numerical models for quantitative economic analysis.

EBGN655. ADVANCED LINEAR PROGRAMMING. 3.0 Semester Hrs.
Equivalent with EBGN650,
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: EBGN555. 3 hours lecture; 3 semester hours.

EBGN690. ECONOMETRICS II. 3.0 Semester Hrs.
A second course in econometrics. Compared to EBGN590, 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, EBGN509, EBGN590. Recommended: EBGN511.

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, EBGN509, EBGN510, EBGN511, EBGN590.

EBGN698. SPECIAL TOPICS IN ECONOMICS AND BUSINESS. 0-6 Semester Hr.
(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.

EBGN698. SPECIAL TOPICS. 0-6 Semester Hr.

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.

Professors

Jared C. Carbone

Ian Lange

Research Professor

Roderick G. Eggert

Associate Professors

Benjamin Gilbert

Steven Smith

Assistant Professors

Maxwell Brown

Hojun Choi

Teaching Professors

Scott Houser, Department Head

Becky Lafrancois

Teaching Associate Professors

Crystal Dobratz

Michael Helwig

Sheron Lawson

Andrew Pederson

Jeremy Suiter

Professor of Practice

Thomas Brady

David Culbreth

Daniel Jerrett

Patrick Leach

Paul Zink

Professors Emeriti

Carol A. Dahl

Graham Davis

Franklin J. Stermole

John E. Tilton

Michael R. Walls