

## Courses in the EBF Curriculum Annotated Discussion

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This is an annotated listing of EBF classes, in order of listing on EBF checksheet.

In the last academic year three changes were approved to the major. The changes were:

- 1) Adding prerequisites to the Energy Systems minor.
- 2) Adding a requirement of “C” for calculus.
- 3) Changing the “W” class in the major from ENNEC 484 to EMSC (EBF) 304.

Conceptually, you could take both ENNEC 484 and EBF 304 without taking a “W” class. In which case, you can get an exemption form signed.

We have added additional technical 400 level electives from the Department of Energy and Mineral Economics.

We are in the process of changing “ENNEC” and “EMSC” classes to “EBF” classes. So if you don’t see the class you are looking for, look under “EBF”.

A couple of students appear to have had their graduations delayed because they did not sign up for ENNEC 473, spring term. We will offer ENNEC 473 in both semesters AY 2009-10, but likely only spring semester AY 2010-11.

We are now asking the faculty senate to require MATH 140 and 141 for the major. This would apply to students entering the major January 2010 and afterwards.

We encourage students to take minors. But you should remember two points.

First, several students have asked to enter the minors in global business strategies and energy, and environmental economics. That isn’t allowed for EBF majors. Basically, you would be asking to both major and minor in EBF.

Second, you want to take a minor that distinguishes you from other job candidates and shows that you have some background in a different field. So a minor in economics, while easy to obtain, is not likely to help you very much. (You can count the ECON 400 level classes listed below for both the EBF major and the ECON minor.) Look for a minor in something different. A foreign language minor is always a good choice. Art and music minors are helpful. For students coming from the engineering college, a minor in engineering entrepreneurship makes a lot of sense.

We also encourage students to know their advisors. Meeting with your advisor regularly can save you lots of trouble. If you don’t know who your advisor is, look on your degree

audit or email Crystal Renaud at [cdr125@psu.edu](mailto:cdr125@psu.edu). If you would like to switch advisors, ask Crystal, and she will choose a new one for you randomly. (You don't get to choose your advisor.) If there is a question your advisor cannot answer, please contact the program officer. But don't contact the program officer first with an issue your advisor can handle. He (me) will simply direct you to talk to your advisor.

Almost all EBF students have course petitions to be signed in order to graduate. So when you need this done, find a petition (the student center has them), fill it out, and give it to your advisor to sign. Then give the petition to Crystal Renaud in Hosler 104. She'll tell me when I need to sign them.

We strongly encourage students with GPAs greater than 3.7 and at least an A- in ENNEC 100 who have not entered their junior year to apply to the Schreyer Honors College. See <http://www.shc.psu.edu/future/gateway.cfm>. If you are in the Honors College, you are required to take ECON 490 as a 400 level elective.

We have had some students express an interest in graduate school in economics or a related field. If this applies to you, please meet with Dr. Kleit as soon as possible. In particular, we have found that these students need to enhance their background by taking additional math and statistics classes. On the other hand, if you are interested in going to law school, it helps to have classes in writing.

Commentary here is not guaranteed to be accurate. Comments welcome.  
Course descriptions from largely from the Penn State "Blue Book,"  
<http://www.psu.edu/bulletins/bluebook/>

### **Required Core Classes**

**[ECON 002](#)** (GS) **INTRODUCTORY MICROECONOMIC ANALYSIS AND POLICY** (3) Methods of economic analysis and their use; price determination; theory of the firm; distribution.

Students should take this as early as possible. It is offered in the summer at most PSU campuses, and equivalents are offered in the summer at most universities.

**[ECON 302](#)** (GS) **INTERMEDIATE MICROECONOMIC ANALYSIS** ( 3) Allocation of resources and distribution of income within various market structures, with emphasis on analytical tools. Prerequisite: [ECON 002](#)

This should be taken immediately after students take ECON 002, though not before sophomore year. It can be taken in the summer at the UP campuses, and equivalents can be taken at many universities.

**[EBF \(EM SC\) 301 GLOBAL FINANCE FOR THE EARTH, ENERGY, AND MATERIALS INDUSTRIES](#) ( 3) The aim of this course is to introduce fundamental concepts of financial management and illustrate their global applications.**

This class is generally scheduled to be offered only in the fall, though we hope to offer in spring 2010. Students should take this the first fall after they have taken ECON 002.

**[EM SC \(Soon EBF\) 304W GLOBAL MANAGEMENT FOR THE EARTH, ENERGY, AND MATERIALS INDUSTRIES](#) ( 3) This class is designed to introduce students to modern management and organization strategies for resource businesses.**

Prerequisite: [ECON 002](#)

The prerequisite is not needed. We will offer it both semesters beginning AY09-10, starting as “W” class in Spring ‘10.

**[EBF \(EM SC\) 401 STRATEGIC CORPORATE FINANCE FOR THE EARTH, ENERGY, AND MATERIALS INDUSTRIES](#) ( 3) Financial decisions corporations in the earth science area make and the tools and analyses used to make these decisions.**

Prerequisite: [ENNEC 100](#), [EM SC 301](#), and junior or senior standing

This course is now offered both semesters. The prerequisites are not needed.

**[ENNEC 100](#) (soon to be EBF 200) (GS) INTRODUCTION TO ENERGY AND EARTH SCIENCES ECONOMICS** (3) Resource use decisions and their effect on local, national, and global development.

This is the introductory course to the major. We are changing it to a 200 level class because we now believe it should be taken sophomore year (unless you are trying to get into the Honors College under “sophomore gate”). It is offered both fall and spring semesters. We expect to offer it on-line Spring ’10. It is not offered in summers, or at any other campus or university.

**[ENNEC \(EBF\) 473 RISK MANAGEMENT IN ENERGY INDUSTRIES](#) ( 3)**

Analysis of strategies for mitigating business risk from market, atmospheric, geophysical uncertainties including the use of energy/mineral commodity futures/options, weather derivatives, and insurance. Prerequisite: [MSIS 200](#) or [STAT 200](#) or [ENNEC 472](#).

Any of the statistics classes below serve as the prerequisite. This is the most challenging, and most relevant to employment opportunities, course in the major. Students seeking a career in the financial services industry should take this class junior year. Less than fully motivated students taking this course senior year should beware – you can fail this class, if you work at it!

Alternatives for this class are difficult to find. It may be helpful to take the new versions of EBF 301 and EBF 401 previously or concurrently. Any of the statistics classes

discussed below acts as a prerequisite. In addition, it may be more helpful to take ENNEC 472 rather than the other statistics classes discussed below.

[ENNEC \(EBF\) 484 ENERGY ECONOMICS](#) ( 3) Economics of energy demand, production, storage, and pricing; advanced energy policy issues including regulation, climate change, new energy technology. Prerequisite: [ECON 002, 3 credits of calculus](#)

The “W” goes off this class Spring ’10. Calculus has been added as a prerequisite.

[IB 303 \(IL\) INTERNATIONAL BUSINESS OPERATIONS](#) ( 3) A survey of the major aspects of international business environment and operations with an emphasis on the cultural dimension. Prerequisite: fifth-semester standing

This class does not appear to be taught at other PSU campuses or during the summer.

[INS 301 RISK AND INSURANCE](#) ( 3) Introduction to the principles and methods of handling business and personal risks; emphasis on insurance techniques. Prerequisite: fourth-semester standing.

This class does not appear to be taught at other PSU campuses or during the summer.

### **Supporting Classes Required**

[EM SC 100S](#) (GWS) **Earth and Mineral Sciences First-Year Seminar** (3) Writing, speaking, and critical thinking skills applied to topics of general interest in Environmental and Materials Science.

Or

[CAS 100](#) (GWS) **Effective Speech** (3) Introduction to speech communication: formal speaking, group discussion, analysis and evaluation of messages.

If you entered the EMS College as a freshman, you took EMSC 100. If you didn't, you need to take CAS 100 and a freshman seminar. You probably already took the freshman seminar. If you are a transfer student, you don't have to take the freshman seminar.

[ACCTG 211 FINANCIAL AND MANAGERIAL ACCOUNTING FOR DECISION MAKING](#) (4) Introduction to the role of accounting numbers in the process of managing a business and in investor decision making.

This is the standard accounting course, taught at every university in the country. The class is less crowded in the summer. Further, it is offered on-line at PSU, but not by the University Park campus. Which means you have to find out about it by looking at the World Campus website, <http://www.worldcampus.psu.edu/index.shtml>

Substitutes can be taken for this class at almost all universities. If you take an accounting course at another university that is only worth 3 credits, the university won't recognize it as "ACCTG 211", but merely "Accounting." So you'll need an exemption sheet signed, which is no problem.

[CMPSC 101](#) (GQ) **INTRODUCTION TO ALGORITHMIC PROCESSES** ( 3)

Properties of algorithms, languages, and notations for describing algorithms, applications of a procedure-oriented language to problem solving. A student may receive credit for only one of the following courses: CMPSC 101, 201C, 201F, CSE 103. Prerequisite: 2 entrance units in mathematics.

Or

[CMPSC 121](#) (GQ) **Introduction to Programming Techniques** (3) Design and implementation of algorithms. Structured programming. Problem solving techniques. Introduction to a high-level language, including arrays, procedures, and recursion. Effective: Summer 2008. Prerequisite: 2 entrance units in mathematics

Or

[CMPSC 200](#) (GQ) **PROGRAMMING FOR ENGINEERS WITH MATLAB** ( 3)

Development and implementation of algorithms in a MATLAB environment, with emphasis on numerical methods for engineering problems. Students can receive credit for only one of the following: CMPSC 101, 201A, 201C, 201F or CSE 103. Prerequisite: [MATH 140](#) Concurrent: [MATH 141](#)

Or

[CMPSC 201](#) (GQ) **PROGRAMMING FOR ENGINEERS WITH C++** ( 3) Effective Date: SP2008 Development and implementation of algorithms in a procedure-oriented language, with emphasis on numerical methods for engineering problems. Students who have passed CMPSC 101, 201F, or CSE 103 may not schedule this course. Prerequisite: [MATH 140](#) Concurrent: [MATH 141](#)

Somehow, CMPSC 101 is divided into two different classes, Visual Basic and C++ programming. Take the C++ programming class. (It should say which is which on the course schedule.) There seem to be several versions of CMSPC 201, any of which is fine.

The idea here is that we want you to take a programming class. Lots of alternatives are available at other universities.

[MATH 110](#) (GQ) **TECHNIQUES OF CALCULUS I** ( 4) Functions, graphs, derivatives, integrals, techniques of differentiation and integration, exponentials, improper integrals, applications. Students may take only one course for credit from

MATH 110, 140, 140A, and 140B. Prerequisite: [MATH 022](#) or satisfactory performance on the mathematics proficiency examination

or

[MATH 140](#) (GQ) **CALCULUS WITH ANALYTIC GEOMETRY I** ( 4) Functions, limits; analytic geometry; derivatives, differentials, applications; integrals, applications. Students may only take one course for credit from MATH 110, 140, 140A, 140B, and 140H. Prerequisite: [MATH 022](#), [MATH 026](#); or [MATH 040](#) or [MATH 041](#) or satisfactory performance on the mathematics proficiency examination

These classes, or their equivalents, are offered in a large number of places and times. Anyone with an interest in engineering or meteorology should take MATH 140. We have put in a “C” requirement for this class. Frankly, if you got a “D” in calculus, you are probably in the wrong major. If you took a 3 credit calculus class elsewhere, you can get an exemption sheet signed to have it count for MATH 110 for the major.

Many students take pre-calculus courses in the math department (i.e., Math 26, Math 40, etc.) According to EMS College rules, these classes do not count toward your 120 credit hours required for University graduation. No, I can’t explain why, and this rule doesn’t make sense to me. But I have been told not to ask for exemptions from it.

[B LAW 243](#) **LEGAL ENVIRONMENT OF BUSINESS** ( 3) Social control through law: courts, basic policies underlying individual and contractual rights in everyday society. May not be used to satisfy Smeal College baccalaureate degree requirements.

Or

[E R M 411](#) **LEGAL ASPECTS OF RESOURCE MANAGEMENT** ( 3) Legal systems and lawmaking processes; property rights in land, water, and wildlife resources; jurisdictional problems in planning resource use. Prerequisite: [E R M 151](#)

BLAW 243 is offered in the summer at various PSU campuses. There may be alternatives available in the summer at other universities. Do not worry about the prerequisite for ERM 411. This class is offered Fall term. You can take ERM 411 in place of BLAW 243 or a 400 level elective, but not both. You can also take BA 241 and BA 242 (together 4 credits) for this requirement, though you have to be in DUS or the Smeal College. These classes are described below.

[B A 241](#) **Legal Environment of Business** (2) Examines the legal system's role and impact regarding business transactions, liability issues, and ownership of intellectual property. Students earning credit for B A 241 may not earn credit toward Smeal College baccalaureate degree for B Law 243 and/or B A 243.

[B A 242](#) **Social and Ethical Environment of Business** (2) Explores the social and

ethical environment of business and ethical decision making in a business context.

[ECON 004](#) (GS) **INTRODUCTORY MACROECONOMIC ANALYSIS AND POLICY** ( 3) National income measurement; aggregate economic models; money and income; policy problems.

Or

[GEOG 126](#) (GS;US;IL) **ECONOMIC GEOGRAPHY** ( 3) The location of economic activity at both macro- and micro-regional levels on the earth's surface.

If you are in the GIS option, you are required to take GEOG 126. If you are in the General option, you can take either, though you need a signed exemption sheet if you want to take GEOG 126.

I have a small preference for ECON 004 over GEOG 126. Some students, however, prefer the smaller class size of GEOG 126. ECON 004, however, is part of the minor in economics, which many EBF students take. ECON 004 not a prerequisite to anything in the EBF curriculum, and so there is no need to take it at a particular time. ECON 004 is offered in the summer at most PSU campuses, and equivalents are offered in the summer at most universities.

[ENNEC 472](#) **QUANTITATIVE ANALYSIS IN EARTH SCIENCES** ( 3) Quantitative analysis of decision making in atmospheric/geophysical sciences: exploratory data analysis, quantification of uncertainty, parametric/non- parametric testing, forecasting, time series analysis. Prerequisite: [MATH 110](#) or [MATH 140](#)

Or

[STAT 301](#) (GQ) **STATISTICAL ANALYSIS I** ( 3) Probability concepts; nature of statistical methods; elementary distribution and sampling theory; fundamental ideas relative to estimation and testing hypotheses. Prerequisite: 3 credits of calculus

Or

[STAT 401](#) **EXPERIMENTAL METHODS** ( 3) Random variables; probability density functions; estimation; statistical tests, t-tests; correlation; simple linear regression; one-way analysis of variance; randomized blocks. Prerequisite: [MATH 111](#) or [MATH 141](#)

Or

[ECON 390](#) **Statistical Foundations for Econometrics** (3) Basic statistical concepts used in economics. Topics include probability distributions, expectations, estimation, hypothesis testing, correlation, and simple regression. Students who have completed

ECON 490 may not schedule this course.

Prerequisite: [MATH 110](#) (or 140)

ENNEC 472 is offered only spring terms. For spring 2010 ENNEC 472 will have a new instructor (Dr. Nese) and a new focus on topics more relevant to EBF students.

Some students come into the EBF program already having taken STAT 200. You still have to take one of the above classes. If you did well in STAT 200 try STAT 401. ECON 390 is going to be phased out in the near future.

Options at other universities are limited because we are requiring a higher level of statistics than other programs.

Some students may have AP Statistics credit from high school, but that is not an acceptable substitute for the statistics requirement.

[PNG 489](#) **ENGINEERING EVALUATION OF OIL AND GAS PROPERTIES** ( 3)  
Application of present worth and rate-of-return analysis; reserve calculations; decline curve analysis; uncertainty and risk analysis to engineering project design and evaluation.  
Prerequisite: ECON 002.

IE 302 is a potential substitute for this class, but talk to the instructor first. The on-line Blue Book lists PNG 405 as a co-requisite, but ignore that. We have requested eliminating that listing. Currently, this class is co-offered as EGEE 497B. This class is offered fall only.

### **Introductory EMS Electives**

There are a large number of potential classes here, not all of whom are listed on the checksheet. Basically any GN Class offered by the College of Earth and Mineral Sciences counts. Below I discuss a few classes most relevant to the major.

[EGEE 101](#) (GN) (MATSC) **ENERGY AND THE ENVIRONMENT** ( 3) Energy utilization and technological development, energy resources, conversion and consequences on the local and global environment, and future energy alternatives.

This is an excellent introduction to energy engineering issues, and is taught by popular instructors.

[EGEE 102](#) (GN) **ENERGY CONSERVATION FOR ENVIRONMENTAL PROTECTION** (3) Exposure to energy efficiency in day-to-day life to save money and energy, and thereby protect the environment.

This is an excellent introduction to energy conservation issues, and is again taught by popular instructors.

[EGEE 120](#) (GS;US;IL) **OIL: INTERNATIONAL EVOLUTION** ( 3) Survey of the commercial development of the world petroleum industry from various international, historical, business, and cultural perspectives.

This course investigates historical issues relevant to the major, and is therefore a good choice for GS, US, and IL requirements.

Students are required to take 9 credits of EMS introductory electives. However, you can use 3 credits (but no more than 3) of a “soft” science class (say ASTRO 001) from another college or 6 credits of a “hard science” class (say Physics 211). But if you are in the general option you can only have 6 credits of substitutes (so you can’t get 3 soft + 6 hard.) I hope that makes sense.

In addition, the Meteorology Department offers METEO 004, Business and Meteorology, which can serve as an introductory EMS elective.

### **Advanced EMS Electives**

There are a number of choices here, and I will only discuss a few. I note that if students desire to concentrate in areas relevant to the major with courses not listed here, I am open to discussions.

[ECON 428](#) **ENVIRONMENTAL ECONOMICS** ( 3) Environmental pollution, the market economy, and optimal resource allocation; alternative control procedures; levels of environmental protection and public policy. Prerequisite: [ECON 302](#) or [ECON 323](#)

This is a well-regarded 400 level elective.

[EM SC 420](#) (SOC;S T S) **ENERGY AND MODERN SOCIETY** ( 3) Technology and economics of energy resources, production, and consumption; environmental factors, exhaustion, new technology

This class is also offered as STS 420, so if the EMSC 420 version is filled, try the STS version. It is being taken out of the EBF curriculum (January 2010) because there is too much overlap between it and other classes.

[GEOSC 454](#) **GEOLOGY OF OIL AND GAS** ( 3) Properties, origin, migration, and occurrence of oil and gas. This course has one or more required field trips for which a fee is charged to the student. Prerequisite: [GEOSC 001](#)

This is a challenging, yet highly relevant class. Speak to the instructor before you sign up for it.

**METEO 473 APPLICATION OF COMPUTERS TO METEOROLOGY ( 3)**

Application of statistical and numerical methods to practical problems in meteorology.

Prerequisite: [CMPSC 101](#), [CMPSC 201C](#), or [CMPSC 201F](#)

This is a challenging class. If you are not also meteorology major or minor, speak with the instructor before signing up.

**GEOG 430 HUMAN USE OF ENVIRONMENT ( 3)** The human use of resources and ecosystems and social causes and consequences of environmental degradation in different parts of the world; development of environmental policy and management strategies.

Prerequisite: [GEOG 030](#)

**GEOG 424 (US;IL) GEOGRAPHY OF THE GLOBAL ECONOMY ( 3)** Focus on industrial location theory, factors in industrial location, studies of selected industries and problems of industrial development. Prerequisite: [ECON 002](#), [ECON 004](#), GEOG 100 .

The former instructor told me you only need 2 of the 3 listed prerequisites.

**GEOG 431 GEOGRAPHY OF WATER RESOURCES ( 3)** Perspectives on water as a resource and hazard for human society; water resource issues in environmental and regional planning. Prerequisite: 6 credits in geography or natural sciences

**GEOG 444 AFRICAN RESOURCES AND DEVELOPMENT ( 3)** Ecological and cultural factors in the geography of Africa; natural resources and development.

Prerequisite: [GEOG 010](#), [GEOG 020](#), [GEOG 030](#), or [GEOG 124](#)

**GEOG 493C COMMUNITY ENERGY SERVICE LEARNING** is a course designed to appeal to students who have an interest in studying the principles of energy supply, use, and transformation in a real-world context, with a particular focus on the relationship of local energy consumption patterns and community socioeconomic consequences. The course will analyze the efficiency of energy use in Centre County as a platform for building a place-based sustainable economy, establish a benchmark data-base, and develop the initial field projects to be implemented as part of the seminar's on-going, long-term goal of materially upgrading the community's energy efficiency.

This class has 10 seats per term, so you will want to sign up as soon as possible, if you are interested.

In addition, some classes not listed in the Blue Book:

**B A 427 RISK AND DECISIONS ( 3)** Conceptualizing decisions involving risk, analyzing choices, estimating the risk, and communicating the analysis. Prerequisite:

[MATH 110](#) or [MATH 140](#) and either [MS&IS 200](#) or [STAT 200](#).

This class is taught fall only, and is generally difficult to get into.

[E RRE 404](#) (AG EC) **METHODS IN NATURAL RESOURCE AND ENVIRONMENTAL ECONOMICS** ( 3) Students will learn empirical research methodology in the areas of environ- mental and natural resource economics. Prerequisite: [AG EC 201](#) or [ECON 302](#), [ECON 428](#)

[E RRE 429](#) (AG EC) **NATURAL RESOURCE ECONOMICS** ( 3) Optimal management of resources; roles of markets and other institutions; resources and economic development; public policy. Prerequisite: [ECON 302](#)

[E RRE 431W](#) (AG EC) **ECONOMIC ANALYSIS OF ENVIRONMENTAL AND RESOURCE POLICIES** ( 3) Economic analysis of environmental and natural resource policies, benefit-cost analysis, non-market valuation techniques; resource damage assessment. Prerequisite: [ECON 302](#)

[PL SC 420](#) **POLICY MAKING AND EVALUATION** ( 3) Advanced analysis of public policy, emphasizing policy evaluation and the factors that determine policy success and failure. Prerequisite: [PL SC 001](#) or [PL SC 002](#)

[ECON 490](#) **INTRODUCTION TO ECONOMETRICS** ( 3) Use of simple and multiple regression models in measuring and testing economic relationships. Problems including multicollinearity, hetroskedasticity, and serial correlation. Prerequisite: MATH 110, [ECON 390](#) (or ENNEC 472 or STAT 301 or STAT 401). This class is required for honors students.

[ECON 402](#) **Decision Making and Strategy in Economics** (3) Development and application of the tools for decision making under uncertainty and for game theoretic analysis of economic problems. Prerequisite: [ECON 302](#);[SCM 200](#) or [STAT 200](#)

[ECON 441](#) **Introduction to Business Economics** (3) The study of economic theory as it relates to the problems of the firm. Prerequisite: [ECON 002](#), [ECON 004](#)

[ECON 442](#) **Managerial Economics** (3) Application of economic theory to managerial decision making; risk, uncertainty; models and statistical techniques. Prerequisite: [ECON 002](#)

[ECON 443](#) **Economics of Law and Regulation** (3) An economic analysis of property rights, contractual arrangements, illegal activities, and regulation; competitive problems due to externalities and market failure. Prerequisite: [ECON 302](#) or [ECON 342](#)

[ECON 444](#) **Economics of the Corporation** (3) Coordination and incentive issues within a corporation. Topics include employment contracts, performance incentives and pricing of financial assets. Prerequisite: [ECON 302](#)

## **ADVANCED TECHNICAL ELECTIVES**

EBF students are required to take 9 credits in 400 level electives. Many students have expressed an interest in taking some technical courses from the Department of Energy and Mineral Engineering.

Below is a list of EME classes that will count toward your 400 level elective requirements. You can only use 3 credits from this list. Make sure you have the relevant prerequisites. Please contact me at [ank1@psu.edu](mailto:ank1@psu.edu) if you have any questions.

Available classes:

**[EGEE 401](#) Energy in a Changing World** (3) Energy is in transition, with increased international energy demand and increasing environmental pressures. Energy transitions, approaches, and outcomes are addressed.

Prerequisite: [EGEE 101](#) or [EGEE 102](#) or [CHEM 112](#)

The prerequisites do not seem to be required. This is taught on-line, and may be taught at University Park Spring 2010.

**[IHS 450](#) Environmental Health and Safety** (3) Overview of toxicology, exposure assessment, industrial hygiene, environmental laws, and contemporary issues in environmental health and safety.

Prerequisite: [CHEM 110](#)

This class is taught fall term. The chemistry prerequisite is not enforced.

**[MN PR 301](#) Elements of Mineral Processing** (3) Introduction to mineral process engineering. Sampling, sizing, comminution, physical and chemical processes, applications to industrial practice. Pollution control.

Prerequisite: [CHEM 110](#) or [CHEM 106](#); [MATH 141](#)

Math 141 is not really required, but chemistry is. This is taught fall term.

**[MNG 030](#) Introduction to Mining Engineering** (2) Examination, development, and exploitation of mineral deposits; mining methods; unit operations; mining equipment; fundamentals of explosives.

A much harder class than it looks on paper. If you take this class, you can get the “missing” one credit hour waived. This is taught fall term.

**[PNG 405](#) Rock and Fluid Properties** (3) Reservoir rock properties, rock and fluid properties (interaction between rock and fluids), flow behavior in reservoir, and fluid properties.

Prerequisite: [PHYS 211](#)

Taught fall term. Make sure you have the physics class.

### Courses in the GIS Option

Below are the courses required for the GIS option.

#### **PRESCRIBED COURSES**

GEOG 126 (discussed above)

[GEOG 160](#) (GS) **MAPPING OUR CHANGING WORLD** ( 3) Fundamental concepts of GIS, cartography, remote sensing, and GPS in the context of environmental and social problems.

This is the introduction to the GIS series. So if you are interested in the GIS option, this is the class to try.

[GEOG 363](#) **GEOGRAPHIC INFORMATION SYSTEMS** ( 3) Principles and use of geographic information; emphasis is on data acquisition and techniques for computer-aided analysis. Prerequisite: [GEOG 160](#)

#### **ADDITIONAL COURSES** (12 credits)

[GEOG 361](#) **CARTOGRAPHY--MAPS AND MAP CONSTRUCTION** ( 3) The art and science of creating small-scale maps as a medium for communication and research. Prerequisite: [GEOG 160](#)

Or

[GEOG 362](#) **IMAGE ANALYSIS** ( 3) Introduction to the basic principles of remote sensing, and the analysis of aerial and satellite data. Prerequisite: [GEOG 160](#)

Or

[GEOG 464](#) **ANALYSIS AND GIS** ( 3) Normative and probabilistic models of spatial behavior; adaptive systems in geographic space; interaction and system stability. Prerequisite: [GEOG 364](#)

Select 9 credits from GEOG 485(3), GEOG 461W(3), GEOG 467(3), GEOG 463(3), GEOG 468(3), GEOG 464(3) [if not taken for requirement above].

[GEOG 485](#) **GIS PROGRAMMING AND CUSTOMIZATION** ( 3) Customizing GIS software to extend its built-in functionality and to automate repetitive tasks. Prerequisite: [GEOG 484](#) or equivalent experience

[GEOG 461W](#) **DYNAMIC CARTOGRAPHIC REPRESENTATION** ( 3) Theory and practice of mapping and geo-representation in a hypermedia context. Applications in science, policy, travel, and education. Prerequisite: [GEOG 361](#), [GEOG 330](#), [GEOG 362](#), [GEOG 356](#), or [GEOG 363](#)

[GEOG 467](#) **APPLIED CARTOGRAPHIC DESIGN** ( 3) Applied computer-assisted map production methods with emphasis on geographic information design and color use for multiple presentation media. Prerequisite: [GEOG 361](#)

[GEOG 463](#) **GEOSPATIAL INFORMATION MANAGEMENT** ( 3) This course examines geospatial data representations and algorithmic techniques that apply to spatially-organized data in digital form. Prerequisite: any earth science computer application course; familiarization with databases and information systems.

[GEOG 468](#) **GEOGRAPHIC INFORMATION SYSTEMS DESIGN AND EVALUATION** ( 3) Design and evaluation of Geographic Information Systems and other forms of integrated spatial data systems. Prerequisite: [GEOG 363](#)

#### **ENERGY SYSTEMS OPTION**

See the Blue Book for listings. The only comment I have is that Math 252 is listed as a prerequisite for EME 301 and 303. But you don't need it. So if you are in this option, you don't have to take Math 252.