



University Bulletin

Undergraduate Degree Programs

Earth and Mineral Sciences

In the COLLEGE OF EARTH AND MINERAL SCIENCES, instruction and research are aimed at increasing our understanding of the Earth and human interactions with the environment; the production and utilization of fuels and mineral resources; and the science and technology of engineered materials.

Study in the College of Earth and Mineral Sciences covers an unusually wide range, from practical industrial problems, fundamental science, and advanced technology to global environmental issues, and human responses to changing social conditions. Degrees are offered in science, engineering, and social science. Programs dealing directly with the Earth and environment include Geosciences, Meteorology, Geography, and Earth Sciences. They also include Energy, Business, and Finance, as well as Environmental Systems Engineering, which focuses on technologies for environmental clean-up and preservation. The production and utilization of energy and natural resources are the focus of Mining Engineering, Industrial Health and Safety, Petroleum and Natural Gas Engineering, and Mineral Economics, while areas dealing with engineering materials include the options offered by the Department of Materials Science and Engineering: Ceramic Science and Engineering, Electronic and Photonic Materials, Metals Science and Engineering, and Polymer Science and Engineering. These subjects also seek to advance the science and technology of composite materials.

The following baccalaureate engineering programs are accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone 410-347-7700: Mining Engineering, Petroleum and Natural Gas Engineering, Environmental Systems Engineering, and Materials Science and Engineering (with options in Ceramic Science and Engineering, Electronic and Photonic Materials, Metals Science and Engineering, and Polymer Science and Engineering). The baccalaureate program in Industrial Health and Safety is accredited by the Applied Science Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone 410-347-7700.

UNDERGRADUATE PROGRAMS

PROFESSOR JOHN R. HELLMANN, *Associate Dean for Education*

The undergraduate programs of the college provide students with a personal and individual educational experience that helps prepare them for a variety of professional careers. They gain a fundamental understanding of their chosen area, acquire the basic skills and attitudes required to become members of their profession, and have opportunities to meet professionals in their field. Students are challenged to maximize their abilities and prepare for a future in which they will welcome continuous learning and professional growth. Undergraduate student services in the college's Ryan Family Student Center reflect a strong emphasis on communications and mathematics skills, housing full-time faculty tutor-instructors in both writing and math. Research and scholarship are encouraged through participation in capstone design courses, undergraduate theses, or research projects. Field work experience is emphasized in several of the earth science-related majors.

CONCURRENT MAJORS IN LIBERAL ARTS AND EARTH AND MINERAL SCIENCES--For a student who wishes to earn a liberal arts degree combined with technical preparation for a career in the earth, mineral, or materials sciences, the college offers a concurrent major program, requiring ten semesters of study, the first six in the College of the Liberal Arts and the last four in the College of Earth and Mineral Sciences. Upon completion of the program, a B.A. is awarded by the College of

the Liberal Arts and a B.S. by the College of Earth and Mineral Sciences. The latter degree may be earned in any of the college's science or engineering programs.

3-2 PROGRAM WITH OTHER INSTITUTIONS AND EARTH AND MINERAL SCIENCES--In the cooperative liberal education 3-2 Program, the student completes three academic years of study in one of the EMS engineering programs at one of several cooperating liberal arts colleges and then transfers to Penn State for two additional academic years (four semesters). Upon completion of the program, the student is awarded the B.A. degree by the liberal arts college and the B.S. degree by this university. Arrangements for the cooperative program are in effect with several colleges in the state. Inquiries concerning admission should be made at the Earth and Mineral Sciences Ryan Family Student Center in 14 Deike Building, University Park campus. For a list of participating 3-2 institutions, please visit the Web site:

www.engr.psu.edu/ProspectiveStudents/Undergraduate/3-2instlist.aspx
(<http://www.engr.psu.edu/ProspectiveStudents/Undergraduate/3-2instlist.aspx>)

TEACHER CERTIFICATION PROGRAMS--It is possible, with careful planning, for students to satisfy requirements for the provisional certificate for teaching in the Commonwealth of Pennsylvania while also satisfying requirements for the bachelor's degree in any major in the College of Earth and Mineral Sciences. Students who want to prepare for teaching certification should consult the certification officer of the College of Education or the Office of the Associate Dean for Education.

INTERNATIONAL STUDY OPPORTUNITIES

There are many ways students may take advantage of a global education, through education abroad opportunities, international internships, and focused international experiences for outstanding juniors and seniors. For more information refer to:

www.ems.psu.edu/students/studyabroad.html
(<http://www.ems.psu.edu/students/studyabroad.html>)

ENGINEERING COOPERATIVE EDUCATION PROGRAM

Students enrolled in the College of Earth and Mineral Sciences engineering programs are eligible for opportunities to pursue up to one full year of career-related experience while earning their undergraduate degree through the Engineering Cooperative Education and Professional Internship Program. For additional information refer to:

www.engr.psu.edu/coop(<http://www.engr.psu.edu/coop>)

CONTINUING AND DISTANCE EDUCATION

Penn State students may acquire course credit in a number of ways in addition to classroom instruction. The World Campus, Penn State's online campus, offers a number of General Education and U.S. and International Cultures courses. See the World Campus Web site (www.worldcampus.psu.edu(<http://www.worldcampus.psu.edu>)) for information regarding prerequisites, registration, and payments. Through the John A. Dutton e-Education Institute (<https://www.e-education.psu.edu>(<https://www.e-education.psu.edu>)), students may pursue certificate programs through the Departments of Geography and Meteorology: Post-baccalaureate Certificate in Geographic Information Systems; Post-baccalaureate Certificate in Geospatial Intelligence; and Certificate of Achievement in Weather Forecasting.

DIVERSITY IN EARTH AND MINERAL SCIENCES

Diversity among students and faculty is a top priority for the dean and the faculty of the College of Earth and Mineral Sciences. We are committed not only to recruiting and retaining our students, but also to helping them to develop professionally and to graduate. We pride ourselves on providing hands-on experiences very early in a student's academic experience. A number of our institutes are designed to internationalize student classwork, research, and internship experiences.

COLLEGE OF EARTH AND MINERAL SCIENCES

WILLIAM E. EASTERLING, *Dean*

ALAN W. SCARONI, *Associate Dean for Research*

JOHN R. HELLMANN, *Associate Dean for Education*

CATHERIN G. LYONS, *Associate Dean for Educational Equity*

COLLEGE ORGANIZATION

Energy and Geo-Environmental Engineering

YAW YEBOAH, *Department Head*

MARK S. KLIMA, *Associate Head for Undergraduate Programs*

Geography

KARL S. ZIMMERER, *Department Head*

LORRAINE DOWLER, *Associate Head for Undergraduate Programs*

Geosciences

TIMOTHY J. BRALOWER, *Department Head*

DAVID M. BICE, *Associate Head for Undergraduate Programs*

Materials Science and Engineering

GARY L. MESSING, *Department Head*

R. ALLEN KIMEL, *Associate Head for Undergraduate Studies*

Meteorology

WILLIAM H. BRUNE, *Department Head*

HAMPTON N. SHIRER, *Associate Head for Undergraduate Programs*

Baccalaureate Degrees

Earth Sciences

University College: Penn State DuBois

University Park, College of Earth and Mineral Sciences (EARTH)

PROFESSOR DAVID M. BICE, *Associate Head for Undergraduate Programs*

This major provides a comprehensive program in environmental sciences based on a strong emphasis in earth sciences. It is especially directed toward study of the problems that arise from the complex interaction of man's technological and social activities with the natural environment. Graduates are in demand for positions in government, industry, and consulting. Professional activities include gathering and evaluating data on environments; management and coordination of specialized programs in environmental control and modification; and industrial and government planning. Suitable choices of courses may qualify students for graduate work in several fields.

For the B.S. degree in Earth Sciences, a minimum of 123 credits is required.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

GENERAL EDUCATION: 45 credits

(21 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in this bulletin.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES:

(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 99-101 credits

(This includes 21 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 6 credits of GWS courses.)

PRESCRIBED COURSES (31 credits)

CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3), CHEM 113 GN(1), EM SC 100S

GWS(3)[\[71\]\(#mnote71\)](#), MATH 140 GQ(4), MATH 141 GQ(4) (Sem: 1-2)

PHYS 211 GN(4), PHYS 212 GN(4) (Sem: 1-4)

BIOL 110(4) (Sem: 3-4)

ADDITIONAL COURSES (36 credits)

ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)

Select 15 credits of introductory earth science from the following list (courses may not double count with minor requirements): EARTH 002 GN(3), EARTH 101 GN(3), EARTH 103 GN(3), EARTH 105 GN(3), METEO 003 GN(3), METEO 022(2), GEOG 030 GS(3), GEOG 110 GN(3), GEOG 111 GN(3), GEOG 115 GN(3), GEOG 160(3), GEOSC 001(3), GEOSC 021 GN(3), SOILS 101 GN(3) (Sem: 1-6)

Select 15 credits[\[11\]\(#mnote01\)](#) of advanced earth science from the following list (courses may not double count with minor requirements): GEOG 430(3), GEOG 438W(3), GEOG 412W(3), GEOSC 204(4), GEOSC 320(3), GEOSC 340(3), GEOSC 402W(3), GEOSC 416(3), METEO 300(4), METEO 431(3), METEO 475(3) (Sem: 3-8)

Select 3 credits of writing-intensive courses from within Earth and Mineral Sciences to include, but not limited to: GEOG 412W(3), GEOG 310W(3), GEOSC 402W(3), GEOSC 470W(3), METEO 471W(3) (Sem: 7-8)

SUPPORTING COURSES AND RELATED AREAS (32-34 credits)

Select 3-4 credits of advanced math, statistics, computer science in consultation with an adviser (Sem: 5-8)

Select 3 credits of field, laboratory experience in consultation with an adviser (Sem: 5-8)

Select 8-9 credits in other approved courses (Students may apply 6 credits of ROTC) (Sem: 5-8)

Select 18 credits[\[11\]\(#mnote01\)](#), in consultation from an adviser, from one of the following Earth and Mineral Sciences interdisciplinary minors:

CLIMATOLOGY

MARINE SCIENCE

WATERSHEDS & WATER RESOURCES

EARTH SYSTEMS

GLOBAL BUSINESS STRATEGIES FOR EARTH AND ENVIRONMENTAL INDUSTRIES

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

[71] The following substitutions are allowed for students attending campuses where the indicated course is not offered: CAS 100 GWS or ENGL 202C GWS can be substituted for EM SC 100S GWS.

Last Revised by the Department: Summer Session 2000

Blue Sheet Item #: 28-05-017

Review Date: 1/20/04

UCA Revision #1: 8/3/06

Department Head Change: 4/12/05

Energy Engineering

University Park, College of Earth and Mineral Sciences (ENENG)

PROFESSOR SARMA V. PISUPATI, *Undergraduate Program Officer*

The undergraduate program in energy engineering is designed to reflect the growing impact and demand for energy in society and to equip students with the knowledge necessary to achieve the following career and professional accomplishments or program educational objectives: become valuable contributors in addressing society's energy needs and demands; successful leaders in advancing the technology and management of energy; innovators and entrepreneurs in the energy sector; and educators, practicing engineers, and national leaders on energy and associated environmental, health and safety, and policy and economics issues. The program integrates skill sets in the physical sciences (chemistry, engineering, mathematics, and physics) and social sciences (economics, policy, and management) to ensure successful career opportunities and growth within energy-related industries, government agencies, and academia.

The courses are structured to enable students to understand engineering fundamentals and apply the knowledge to solve problems in the production, processing, storage, distribution, and utilization of energy using multiple techniques as synthesis, analysis, design and case studies. Inquiry-based teaching methods and lab experiences are emphasized. The faculty research and scholarly activities are integrated into the curriculum. The program is designed to train students to be lifelong learners, problem solvers, and energy industry leaders. The educational opportunities are sufficiently flexible, broad, and diverse to enable students to tailor their educational experience to particular interests, background, and expected role in society. Flexibility in the curriculum allows other students in energy related programs such as agricultural and biological, chemical, civil, electrical, environmental, mechanical, mining, nuclear, and petroleum engineering, materials science and engineering, industrial health and safety, and energy business and finance to have dual or concurrent degrees, minors, or options (e.g., energy and fuels engineering option in chemical engineering).

The integration of knowledge and skills acquired should enable graduates of the program to accomplish the following program educational outcomes:

- Solve energy and associated environmental problems using the fundamental knowledge in basic mathematical, chemical, physical, and social sciences learned.
- Design and conduct experiments, acquire data, and define, analyze, and interpret data, and solve practical, complex, energy engineering problems.
- Integrate professional, ethical, social, and environmental factors in energy engineering design and problem solving and understand the impact of these factors on global energy issues.
- Develop the ability to communicate effectively in writing and orally and build teamwork.
- Acquire the desire for lifelong learning to maintain technical competence and keep abreast of new developments in the field.

For the B.S. in Energy Engineering, a minimum of 131 credits is required.

GENERAL EDUCATION: 45 credits

(30 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in this bulletin.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES:

(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 101 credits

(This includes 30 credits of General Education courses: 3 credits of GH courses; 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GS courses; 9 credits of GWS courses.)

PRESCRIBED COURSES (89 credits)

CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3), EM SC 100S GWS(3)[\[88\]\(#mnote88\)](#), MATH 140 GQ(4), MATH 141 GQ(4), PHYS 211 GN(4) (Sem: 1-2)
CHEM 210(3), E E 220(3), MATH 231(2), MATH 251(4), PHIL 103 GH(3), PHYS 212 GN(4) (Sem: 3-4)
EGEE 012(1), EGEE 302(3)[\[1\]\(#mnote01\)](#), EGEE 304(3)[\[1\]\(#mnote01\)](#), EGEE 410(3)[\[1\]\(#mnote01\)](#), EGEE 430(3)[\[1\]\(#mnote01\)](#), EGEE 438(3)[\[1\]\(#mnote01\)](#), EME 301(3)[\[1\]\(#mnote01\)](#), F SC 431(3), MATSE 201(3) (Sem: 5-6)
ENGL 202C GWS(3), EGEE 437(3), EGEE 441(3)[\[1\]\(#mnote01\)](#), EGEE 451(3)[\[1\]\(#mnote01\)](#), EGEE 464W(3)[\[1\]\(#mnote01\)](#), EGEE 494(2)[\[1\]\(#mnote01\)](#), F SC 432(3) (Sem: 7-8)

ADDITIONAL COURSES (12 credits)

E B F 200 GS(3) or ECON 002 GS(3) or ECON 014 GS(3); ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)
CMPSC 201 GQ(3) or CMPSC 202 GQ(3) or EM SC 468(3) (Sem: 3-4)
I E 302(3) or P N G 489(3) (Sem: 7-8)

SUPPORTING COURSES AND RELATED AREAS (15 credits)

Select 3 credits of EGEE electives from an approved list in consultation with an adviser.
Select 6 credits of professional courses from an approved list in consultation with an adviser.
Other substitutions outside the approved list must be approved by petition.
Select 6 credits of technical electives from a broad list of energy related courses across colleges at Penn State. A list of suggested courses from energy-related departments at Penn State is provided. (Students may apply 6 credits of ROTC to some of the elective choices.) (Sem: 7-8)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

[88] The following substitutions are allowed for students attending campuses where the indicated course is not offered: CAS 100 GWS can be substituted for EM SC 100S GWS; and an appropriate electrical circuits course may be approved as a substitute for EE 220.

Last Revised by the Department: Fall Semester 2007

Blue Sheet Item #: 35-05-073

Review Date: 6/11/08

EM

Energy Business and Finance

*University Park, College of Earth and Mineral Sciences (EBF)
University Park, Smeal College of Business*

The major in Energy Business and Finance, offered jointly by the College of Earth and Mineral Sciences and the Smeal College of Business, combines training in business, economics, finance, and the physical sciences with a core of courses focusing on energy and related industries. The major helps students prepare for careers in the energy industry, as well as financial institutions, nonprofit groups, and international organizations dealing with energy issues. The curriculum also provides a strong base for further study in business, economics, law, and social sciences.

GENERAL OPTION

The General option of the Energy Business and Finance major is appropriate for students who want a broad understanding of the earth and environmental sciences in preparation for careers in industry, commerce, and government.

GEOGRAPHIC INFORMATION SYSTEMS OPTION

This option in the major in Energy Business and Finance is appropriate for students who want a

broad understanding of the earth and environmental sciences in preparation for careers in industry, commerce, and government. Such an understanding is available through the designated course work in Geographic Information Systems. The option is designed to develop competence in description, analysis, explanation, and management of problems arising from human use of natural resources and natural systems. GIS is an important tool that can be used to assess natural resources and environmental impacts across various geographic environments. Using GIS brings further depth to the analysis of the impacts of a variety of policy measures. These issues are of great prominence in the energy and natural resource industries, and the regulation of those industries. This curriculum also provides a strong base for further study in business, economics, law, and social sciences.

ENERGY SYSTEMS OPTION

EBF graduates will spend much of their professional careers working with engineers on a variety of energy related projects, or will desire a strong understanding of energy technologies and processes in order to make good financial and management decisions. The Energy Systems Option is designed to give EBF graduates a more rigorous background in engineering principles and applications together with a demanding economics and business curriculum. The option will give students a basic understanding of chemistry, physics, and other engineering principles critical to energy industries and technologies. Students will also take advanced courses in both energy engineering and economics.

For the B.S. degree in Energy Business and Finance, a minimum of 120 credits is required.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

GENERAL EDUCATION: 45 credits

(30 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)
(See description of General Education in this bulletin.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES:

(Included in REQUIREMENTS FOR THE MAJOR)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

ELECTIVES: 8-25 credits

REQUIREMENTS FOR THE MAJOR: 84-97 credits

(This includes 30 credits of General Education Courses: 9 credits of GN courses, 9 credits of GWS courses, 6 credits of GQ courses, and 6 credits of GS courses.)

COMMON REQUIREMENTS FOR THE MAJOR (ALL OPTIONS): 60-61 credits

PRESCRIBED COURSES (45 credits)

MATH 140 GQ(4)[\[1\]\(#mnote01\)](#) (Sem: 1)

MATH 141 GQ(4)[\[1\]\(#mnote01\)](#) (Sem: 2)

ECON 002 GS(3)[\[1\]\(#mnote01\)](#), EM SC 100S GWS(3) (Sem: 1)

E B F 200 GS(3)[\[1\]\(#mnote01\)](#) (Sem: 3)

ACCTG 211(4), ECON 302 GS(3) [\[1\]\(#mnote01\)](#) (Sem: 3-4)

E B F 301(3), E B F 304W(3) (Sem: 5-6)

I B 303 IL(3), INS 301(3) (Sem: 5-8)

E B F 401(3)[\[1\]\(#mnote01\)](#), E B F 473(3), ENNEC 484(3)[\[1\]\(#mnote01\)](#) (Sem: 7-8)

ADDITIONAL COURSES (15-16 credits)

CMPSC 101 GQ(3), CMPSC 200 GQ(3), CMPSC 201 GQ(3), CMPSC 202 GQ(3), or EM SC 468(3) (Sem: 1-2)

ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)

B A 243(4), B LAW 243(3), or E R M 411(3) (Sem: 3-4)

E B F 472(3), STAT 301 GQ(3), or STAT 401(3) (Sem: 3-4)

ENGL 202C GWS(3) or ENGL 202D GWS(3) (Sem: 7-8)

REQUIREMENTS FOR THE OPTION: 24-36 credits

GENERAL OPTION: (24 credits)

ADDITIONAL COURSES (24 credits)

ECON 004 GS(3) (Sem: 3-4)

P N G 489(3) (Sem: 3-4)

Select 9 credits from: EARTH 100 GN(3), EARTH 101 GN;US(3), EARTH 103 GN(3), EARTH 111 GN;US(3), EARTH 150 GN(3), EGEE 101 GN(3), EGEE 102 GN(3), EGEE 120 GS;US;IL(3), GEOG 110 GN(3), GEOG 115 GN(3), GEOSC 002 GN(3), GEOSC 010 GN(3), GEOSC 020 GN(3), GEOSC 021 GN(3), GEOSC 040 GN(3), MATSE 081 GN;IL(3), METEO 003 GN(3), METEO 101 GN(3) (Sem: 3-6)
Select 9 credits from: CED 404(3), E RRE 429(3), E RRE 431W(3), ECON 428(3), ECON 490(3), GEOG 424 US;IL(3), GEOG 430(3), GEOG 431(3), GEOG 444(3), GEOG 493C(3), GEOSC 402Y IL(3), GEOSC 454(3), METEO 473(3), PL SC 490(3) (Sem: 5-8)

GEOGRAPHIC INFORMATION SYSTEMS OPTION (27 credits)

PRESCRIBED COURSES (9 credits)

GEOG 126 GS;US;IL(3) [1](<http://www.psu.edu/bulletins/bluebook/major/ebf.htm#mnote01>) (Sem: 3-4)

GEOG 160 GS(3) [1](<http://www.psu.edu/bulletins/bluebook/major/ebf.htm#mnote01>), GEOG 363(3) (Sem: 3-4)

ADDITIONAL COURSES (18 credits)

Select 6 credits from: EARTH 100 GN(3), EARTH 101 GN;US(3), EARTH 103 GN(3), EARTH 111 GN;US(3), EARTH 150 GN(3), EGEE 101 GN(3), EGEE 102 GN(3), GEOG 110 GN(3), GEOG 115 GN(3), GEOSC 002 GN(3), GEOSC 010 GN(3), GEOSC 020 GN(3), GEOSC 021 GN(3), GEOSC 040 GN(3), MATSE 081 GN;IL(3), METEO 003 GN(3), METEO 101 GN(3), EGEE 120 GS;US;IL(3) (Sem: 3-6)

Select 3 credits from GEOG 361(3), GEOG 362(3), GEOG 464(3) (Sem: 5-6)

Select 9 credits from GEOG 461W(3), GEOG 463(3), GEOG 464(3), GEOG 467(3), GEOG 468(3), GEOG 485(3) [if not taken for requirement above] (Sem: 6-8) (Advanced GIS Elective)

ENERGY SYSTEMS OPTION (36 credits)

PRESCRIBED COURSES (18 credits)

CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3) (Sem: 1-2)

PHYS 211 GN(4) (Sem: 3)

PHYS 212 GN(4) (Sem: 4)

P N G 489(3) (Sem: 5)

SUPPORTING COURSES AND RELATED AREAS (18 credits)

Select 9 credits in Engineering Principles:

EME 301(3) [1](<http://www.psu.edu/bulletins/bluebook/major/ebf.htm#mnote01>) (Sem:5)

EME 303 (3) [1](<http://www.psu.edu/bulletins/bluebook/major/ebf.htm#mnote01>) (Sem:5-6)

And 3 credits from: EGEE

302(3) [1](<http://www.psu.edu/bulletins/bluebook/major/ebf.htm#mnote01>), EGEE

304(3) [1](<http://www.psu.edu/bulletins/bluebook/major/ebf.htm#mnote01>), EGEE

430(3) [1](<http://www.psu.edu/bulletins/bluebook/major/ebf.htm#mnote01>), M E

430(3) [1](<http://www.psu.edu/bulletins/bluebook/major/ebf.htm#mnote01>) (Sem: 5-6)

Select 9 credits in Engineering Applications from:

EGEE 420(3), EGEE 430(3) or M E 430(3), EGEE 437(3), EGEE 438(3), EGEE 441(3), EGEE 451(3), EGEE 470(3) or M E 470(3) [if not taken for requirement above], F SC 431(3), F SC 432(3) (Sem: 5-8)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

Last Revised by the Department: Fall Semester 2009

Blue Sheet Item #: 38-02-020

Review Date: 10/6/09

UCA Revision #1: 8/3/06

Minor editorial changes to comply with University editorial style (Publications): 8/23/06

EM

Environmental Systems Engineering

University Park, College of Earth and Mineral Sciences (ENVSE)

PROFESSOR M. THADDEUS ITYOKUMBUL, *Undergraduate Program Officer*

The B.S. program in Environmental Systems Engineering is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone: 410-347-7700. It is an interdisciplinary program with two options. One option is Environmental Systems Engineering and it is concerned with the impact of industrial activities on the environment and the choice of cost-effective remediation strategies. The other option is Environmental Health and Safety Engineering and it is concerned with safe and healthful design of industrial systems such that workers are protected from potentially high risk exposures associated with today's industries. The program is unique as it is designed to address critical environmental, safety and health problems of the basic industries such as those involved in the extraction, conversion, and utilization of energy and mineral resources. The courses are sequenced so that students acquire an appropriate blend of theory, applications, and design and are equipped with the fundamentals necessary to maintain lifelong professional growth. Graduates are prepared to enter both the private and public sectors as environmental systems engineers or health and safety engineers or to pursue further education at the graduate level.

During the first two years, the program shares many common features (e.g., mathematics, chemistry, physics, and engineering mechanics) with other more traditional engineering disciplines. Students then take a series of special courses that introduce engineering concepts in the extractive and process industries. Process engineering and a variety of solid-solid, solid-fluid, and fluid-fluid separations play a major and often dominant role in the prevention and/or remediation of environmental damage or the prevention of health and safety hazards resulting from industrial activity. Students then specialize in the particular problems associated with air, land, or water, environmental health and safety engineering or select a hybrid program. Specialization is accomplished through a combination of additional designated courses and selection from an extensive list of relevant elective courses, which may include a senior thesis. The curriculum is structured so as to integrate design concepts into the various subject areas covered in the program.

The human, societal, economic, ethical, and regulatory aspects of the industrial impact on the environment and on the workers themselves are addressed through a combination of specific courses and components of other more general courses. This aspect of the program is designed to provide students with a deeper understanding, both of the impact of environmental degradation on society and of the effects on industrial activity of society's demands for protection of workers and the environment. The program culminates with the capstone design course, which is an integrated, problem-based, multi-faceted project in which students, working in a team setting, utilize fundamental concepts to design an environmental remediation system or an environmental health and safety protection system (or incorporate these design requirements into other associated designs).

The integration of knowledge and skills acquired during the course of study enables graduates of Penn State's Environmental Systems Engineering program to:

Enter the private or public sectors as environmental systems engineers to solve a broad range of environmental or health and safety problems associated with the resource recovery and general and process industries or pursue an advanced degree.

Address critical environmental or health and safety problems of the basic industries,

especially those involved with the extraction, conversion, and utilization of energy and mineral resources; design effective and economic engineering systems to alleviate such problems, individually and in a team setting; and communicate the results effectively.

Determine the impact of environmental pollution control on the viability of industrial operations, including health and safety, social, and ethical aspects, and an awareness of environmental regulations; evaluate novel strategies for minimizing pollution control costs in the process industries.

Recognize the need to maintain professional competency and the value of life-long learning.

For the B.S. degree in Environmental Systems Engineering, a minimum of 131 credits is required.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

GENERAL EDUCATION: 45 credits

(27 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in front of *Bulletin*.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES:

(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 113-114 credits

(This includes 27 credits of General Education courses; 9 credits of GWS courses; 6 credits of GQ courses; 9 credits of GN courses; 3 credits of GS courses.)

COMMON REQUIREMENTS FOR THE MAJOR (ALL OPTIONS): 92-93 credits

PRESCRIBED COURSES (72 credits)

EM SC 100S GWS(3)[\[71\]\(#mnote71\)](#) (Sem: 1-2)

CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3), CHEM 202(3), E MCH 211(3), E MCH 212(3), MATH 140 GQ(4), MATH 141 GQ(4), MATH 251(4), PHYS 211 GN(4), PHYS 212 GN(4), C E 370(3)[\[1\]\(#mnote01\)](#), EGEE 301(6) (Sem: 3-6)

ENGL 202C GWS(3)[\[1\]\(#mnote01\)](#), GEOSC 452(3), MN PR 301(3)[\[1\]\(#mnote01\)](#) (Sem: 5-6)

GEOEE 404W(3), GEOEE 406(3), GEOEE 427(3)[\[1\]\(#mnote01\)](#), GEOEE 480(3), I H S 450(3) (Sem: 5-8)

ADDITIONAL COURSES (11-12 credits)

ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)

CMPSC 201 GQ(3) or CMPSC 202 GQ(3), or CMPSC 203 GQ(4) (Sem: 3-4)

MATH 220 GQ(2) or MATH 231(2) (Sem: 3-4)

GEOSC 001(3) or GEOSC 071(3) [\[1\]\(#mnote01\)](#) (Sem: 3-6)

SUPPORTING COURSES AND RELATED AREAS (9 credits)

Select 9 credits in consultation with adviser (Sem: 7-8)

(Students may apply up to 6 credits of ROTC.)

REQUIREMENTS FOR THE OPTION: 21 credits

ENVIRONMENTAL SYSTEMS ENGINEERING OPTION: (21 credits)

PRESCRIBED COURSES (12 credits)

GEOG 030 GS(3), MICR B 106 GN(3) (Sem: 1-4)

EGEE 470(3), GEOEE 412(1), MNG 401(1), P N G 411(1) (Sem: 5-6)

ADDITIONAL COURSES (9 credits)

GEOSC 413W(3), SOILS 401(3), or METEO 455(3) (Sem: 7-8)

METEO 454(3), MN PR 401(3), or MN PR 426(3) (Sem: 7-8)

GEOEE 408(3), M E 433(3), or MN PR 425(3) (Sem: 7-8)

ENVIRONMENTAL HEALTH AND SAFETY ENGINEERING OPTION: (21 credits)

PRESCRIBED COURSES (21 credits)

BIOL 141 GN(3), PSYCH 100 GS(3) (Sem: 1-4)

I H S 495W(2), ME 405(3) (Sem: 5-6)

I H S 400(3), I H S 447(4), I H S 470(3) (Sem: 7-8)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

[71] The following substitutions are allowed for students attending campuses where the indicated course is not offered: CAS 100 GWS or ENGL 202C GWS can be substituted for EM SC 100S GWS.

Last Revised by the Department: Summer Session 2009

Blue Sheet Item #: 37-03-011

Review Date: 11/18/08

UCA Revision #1: 8/4/06

UCA Revision #2: 7/27/07

EM

Geobiology

University Park, College of Earth and Mineral Sciences (GEOBI)

PROFESSOR DAVID M. BICE, *Associate Head for Undergraduate Programs*

Geobiology is the interdisciplinary study of the Earth and its biosphere. It embraces the history of life and its interactions with the Earth over geologic time; it also includes study of interactions between living organisms and physical and chemical processes in the modern environment on Earth, and possibly elsewhere in the universe. Thus, geobiology encompasses the fields of paleobiology and paleontology, biogeochemistry, geomicrobiology, and astrobiology. The degree program provides students with a strong background in general science and especially in Geosciences and Biology, with core selections from both disciplines. Students gain practical field experience in the study of the physical environment and ecological properties. The senior thesis provides students with hands-on research experience, as well as an emphasis on data synthesis and the written expression of scientific observations and ideas. Students will be well prepared for advanced studies in this emerging discipline, and for careers in the environmental sciences. Geobiology is critical to the study of environmental quality, global change and environmental-human health interactions, all of which have profound importance in legal, economic, and policy arenas.

For the B.S. degree in Geobiology, a minimum of 121 credits is required.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

GENERAL EDUCATION: 45 credits

(21 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in this bulletin.)

FIRST-YEAR SEMINAR:

(Included in ELECTIVES or GENERAL EDUCATION course selection)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES :

(Included in ELECTIVES, GENERAL EDUCATION course selection, or REQUIREMENTS FOR THE MAJOR)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 97 credits

(This includes 21 credits of General Education courses: 9 credits of GN courses, 6 credits of GQ courses, 6 credits of GWS courses.)

PRESCRIBED COURSES (54 credits)

BIOL 110 GN(4)[\[1\]\(#mnote01\)](#), BIOL 220W GN(4)[\[1\]\(#mnote01\)](#), EM SC 100S

GWS(3)[\[71\]\(#mnote71\)](#), MATH 140 GQ(4), MATH 141 GQ(4) (Sem: 1-2)

CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3), CHEM 113 GN(1), PHYS 211 GN(4), PHYS 213 GN(2) (Sem: 1-4)

GEO SC 001(3) [if GEO SC 001 is not available, GEO SC 020 GN(3) may be substituted] (Sem: 1-6)

GEO SC 201(4), GEO SC 204(4) [\[1\]\(#mnote01\)](#) (Sem: 3-6)

GEO SC 310(4) [\[1\]\(#mnote01\)](#) (Sem: 5-6)

GEO SC 494W(3), GEO SC 496(3) (Sem: 7-8)

ADDITIONAL COURSES (13-14 credits)

ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)

Select 4 credits from GEO SC 202(4), GEO SC 203(4) (Sem: 3-6)

Select 3-4 credits from BIOL 230W GN(4), BIOL 240W GN(4), MICRB 201(3) (Sem: 3-6)

Select 3 credits of field experience from BIOL 444(3), GEO SC 472A(3) (Sem: 5-8)

SUPPORTING COURSES AND RELATED AREAS (29-30 credits)

Select 17-18 credits, in consultation with advisor, supportive of the student's interest. (Students may apply 6 credits of ROTC) (Sem: 3-8)

Select 12 credits, at least 3 credits from each category, from the approved list of evolution, paleobiology and geology courses and biogeochemistry courses (Sem: 7-8)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

[71] The following substitutions are allowed for students attending campuses where the indicated course is not offered: CAS 100 GWS or ENGL 202C GWS can be substituted for EM SC 100S GWS.

Last Revised by the Department: Summer Session 2007

Blue Sheet Item #: 35-01-129

Review Date: 8/29/06

UCA Revision #1: 8/8/06

Department Head Changed: 4/12/05

EM

Geography

University Park, College of Earth and Mineral Sciences (GEOBA)

PROFESSOR KARL S. ZIMMERER, *Head*

Geography is simultaneously a social-behavioral and an environmental science. Geographers describe, analyze, and explain the arrangement of the human and physical features on the Earth's surface. The Liberal Arts major stresses the social and behavioral aspects of geography; the Earth and Mineral Sciences major stresses the discipline's environmental perspectives. Both majors provide training in descriptive and analytical skills such as map reading, cartography, and statistics. Substantive course work in the Liberal Arts major focuses on the ways people have arranged themselves and their economic, social, and political activities on the surface of the Earth.

Bachelor's degree program graduates may find employment in federal, state, and local administrative and planning agencies or in private firms that specialize in marketing and environmental research. The Liberal Arts Geography major is especially appropriate for students

seeking a deeper understanding of the human experience and for students intending to pursue postgraduate work in geography or related disciplines.

An internship program enables students to obtain work experience in the public or private sector while they are earning academic credit toward their degrees.

For the B.A. degree in Geography, a minimum of 124 credits is required.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

GENERAL EDUCATION: 45 credits
(See description of General Education in this bulletin.)

FIRST-YEAR SEMINAR:
(Included in ELECTIVES or GENERAL EDUCATION course selection)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES:
(Included in ELECTIVES, GENERAL EDUCATION course selection, or REQUIREMENTS FOR THE MAJOR)

WRITING ACROSS THE CURRICULUM:
(Included in ELECTIVES, GENERAL EDUCATION course selection, or REQUIREMENTS FOR THE MAJOR)

ELECTIVES: 22 credits

BACHELOR OF ARTS DEGREE REQUIREMENTS: 24 credits
(3 of these 24 credits are included in the REQUIREMENTS FOR THE MAJOR, GENERAL EDUCATION, or ELECTIVES and 0-12 credits are included in ELECTIVES if foreign language proficiency is demonstrated by examination.)
(See description of Bachelor of Arts Degree Requirements in this bulletin.)

REQUIREMENTS FOR THE MAJOR: 33 credits [\[1\]\(#mnote01\)](#)

PRESCRIBED COURSES (15 credits)
GEOG 010 GN(3), GEOG 020 GS(3), GEOG 030 GS(3) (Sem: 1-4)
GEOG 160 GS(3), GEOG 364(3) (Sem: 5-6)

ADDITIONAL COURSES (18 credits)
GEOG 126 GS(3) or GEOG 120 GS(3) (Sem: 3-6)
Select 3 credits from GEOG 110 GN(3), GEOG 111 GN(3), GEOG 115 GN(3) (Sem: 3-6)
Select 3 credits from GEOG 123 GS;IL(3), GEOG 124 GS(3), or GEOG 128 GS;IL(3) (Sem: 3-6)
Select 3 credits from GEOG 122 GH(3), GEOG 401W(3), or GEOG 444(3) (Sem: 5-8)
Select 6 credits from 400-level GEOG courses (Sem: 5-8)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

Last Revised by the Department: Summer Session 1997

Blue Sheet Item #: 25-07-023

Review Date: 7/6/06

EM (Transferred from the College of the Liberal Arts--effective FA2006)

Publications updated department head: 9/2/08

Geography

University Park, College of Earth and Mineral Sciences (GEOBS)

PROFESSOR KARL S. ZIMMERER, *Head*

Geographers describe, analyze, and explain patterns of physical and human phenomena on the Earth's surface. Geography is simultaneously an environmental science and a social-behavioral science. This major helps provide grounding in analytical techniques such as map reading, cartography, and statistics. Substantive course work investigates the ways people use environmental resources and how they arrange themselves and their economic, social, and political activities on the Earth's surface.

The Geography major can provide preparation for a career in business, industry, or government. Geographers with bachelor's degrees are currently being placed in federal, state, and local administrative and planning agencies and in private firms that specialize in planning and development or in environmental and socioeconomic analysis.

GENERAL OPTION: This option is designed to serve the needs of students who want to learn about the various topics and perspectives that comprise the discipline of geography. The General option is appropriate both for students who intend to pursue postgraduate degrees and for students who want to emphasize a topic for which no option exists.

GEOGRAPHIC INFORMATION SCIENCE OPTION: This option helps prepare students for entry-level positions in public and private mapping/remote sensing agencies and firms. The student may specialize in one or all of the areas covered in the option. This option is appropriate for students intending to pursue advanced degrees with specialization in these fields.

PHYSICAL/ENVIRONMENTAL GEOGRAPHY OPTION: This option is appropriate for students who want a broad understanding of the earth and environmental sciences in preparation for careers in industry, commerce, and government. The option is designed to develop competence in description, analysis, explanation, and management of problems arising from human use of natural resources and natural systems.

HUMAN GEOGRAPHY OPTION: This option is appropriate for students who want to study Economic Geography and Political Economy; Urban Development and Planning; History, Culture, and Politics; and Nature, Society, and Culture, applying geographical analysis to development opportunities and problems.

Geography courses satisfying the United States Cultures and International Cultures requirement: GEOG 020 GS;US;IL(3), GEOG 040 GS;IL(3), GEOG 120 GS;US;IL(3), GEOG 123 GS;IL(3), GEOG 124 GS;IL(3), GEOG 126 GS;US;IL(3), GEOG 128 GS;IL(3), GEOG 420Y US;IL(3), GEOG 424Y US;IL(3), GEOG 426 IL(3), and GEOG 427 US;IL(3).

Geography courses satisfying the Writing requirement: GEOG 423Y US(3), GEOG 438W(3), GEOG 424Y US;IL(3), GEOG 420Y US;IL(3), GEOG 461W(3), GEOG 412W(3), GEOG 310W(3), and GEOG 411W(3). All students must satisfactorily complete at least one writing-intensive course in Geography.

For the B.S. degree in Geography, a minimum of 120 credits is required.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

GENERAL EDUCATION: 45 credits
(12 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)
(See description of General Education in this bulletin.)

FIRST-YEAR SEMINAR:
(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES:
(Included in ELECTIVES, GENERAL EDUCATION course selection, or REQUIREMENTS FOR THE MAJOR)

WRITING ACROSS THE CURRICULUM:
(Included in REQUIREMENTS FOR THE MAJOR)

ELECTIVES: 11 credits

REQUIREMENTS FOR THE MAJOR: 76 credits
(This includes 12 credits of General Education courses: 6 credits of GQ courses; 6 credits of GWS

courses.)

COMMON REQUIREMENTS FOR THE MAJOR (ALL OPTIONS): 46 credits

PRESCRIBED COURSES (28 credits)

EM SC 100S GWS(3)[\[71\]\(#mnote71\)](#) (Sem: 1-2)

GEOG 010 GN(3)[\[1\]\(#mnote01\)](#), GEOG 020 GS;US;IL(3)[\[1\]\(#mnote01\)](#), GEOG 030 GS(3)[\[1\]\(#mnote01\)](#), GEOG 040 GS;IL(3), GEOG 160 GS(3), STAT 200 GQ(4) (Sem: 1-4)
GEOG 301(3), GEOG 364(3) (Sem: 5-6)

ADDITIONAL COURSES (18 credits)

ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)

Select 6 credits from: MATH 017 GQ(3), MATH 018 GQ(3), MATH 021 GQ(3), MATH 022 GQ(3), MATH 026 GQ(3), MATH 040 GQ(5), MATH 041 GQ(3), MATH 110 GQ(4), MATH 111 GQ(2), MATH 140 GQ(4), MATH 140A GQ(6), or MATH 141 GQ(4) (Sem: 1-4)

PHYSICAL GEOGRAPHY

Select 3 credits from: GEOG 110 GN(3)[\[1\]\(#mnote01\)](#), GEOG 111 GN(3)[\[1\]\(#mnote01\)](#), or GEOG 115 GN(3)[\[1\]\(#mnote01\)](#) (Sem: 3-6)

HUMAN GEOGRAPHY

Select 3 credits from: GEOG 126 GS;US;IL(3)[\[1\]\(#mnote01\)](#), GEOG 122 GH;US(3), GEOG 123 GS;IL(3), GEOG 120 GS;US;IL(3)[\[1\]\(#mnote01\)](#), GEOG 124 GS;IL(3), GEOG 128 GS;IL(3), or GEOG 130 GS(3) (Sem: 3-6)

Select 3 credits of EM SC 300 or GEOG 495 in any combination (Sem: 5-8)

REQUIREMENTS FOR THE OPTION: 30 credits

GENERAL OPTION: (30 credits)

PRESCRIBED COURSES 6 credits

GEOG 333(3), GEOG 363(3) (Sem: 5-8)

ADDITIONAL COURSES (24 credits)

Select 3 credits from GEOG 310W(3), GEOG 313(3), GEOG 430(3), or GEOSC 340(3) (Sem: 5-8)

Select 3 credits from GEOG 420Y US;IL(3), GEOG 423Y US(3), GEOG 426 US;IL(3), or GEOG 429 US(3) (Sem: 5-8)

Select 3 credits from GEOG 361(3), GEOG 362(3), or GEOG 464(3)

Select 15 credits from all remaining 300- and 400-level GEOG courses (Sem: 5-8)

GEOGRAPHIC INFORMATION SCIENCE OPTION: (30 credits)

PRESCRIBED COURSES (12 credits)

GEOG 361(3), GEOG 362(3) (Sem: 3-6)

GEOG 363(3), GEOG 464(3) (Sem: 5-8)

ADDITIONAL COURSES (18 credits)

Select 6 credits from GEOG 461W(3) or GEOG 463(3) (Sem: 5-8)

Select 6 credits from GEOG 467(3), GEOG 468(3), or GEOG 485 (Sem: 5-8)

Select 6 credits from GEOG 461W(3), GEOG 463(3), GEOG 467(3), GEOG 468(3), GEOG 485(3), or GEOG 495G(3) (Sem: 5-8)

PHYSICAL/ENVIRONMENTAL GEOGRAPHY OPTION: (30 credits)

PRESCRIBED COURSES (15 credits)

GEOG 310W(3), GEOG 311(3), GEOG 313(3) and GEOSC 340(3), GEOG 333(3) (Sem: 5-8)

ADDITIONAL COURSES (15 credits)

Select 6 credits from GEOG 110 GN(3), GEOG 111 GN(3), or GEOG 115 GN(3) (Sem: 3-6)

Select 9 credits from GEOG 411(3), GEOG 412W(3), GEOG 417(3), GEOG 430(3), GEOG 431(3), GEOG 438W(3), or GEOG 493(3) (Sem: 5-8)

HUMAN GEOGRAPHY OPTION: (30 credits)

ADDITIONAL COURSES (30 credits)

Select 3 credits from three of the following four groups; 3 credits from a fourth group must match the 100-level Human Geography course taken above:

GEOG 126 GS;US;IL(3), GEOG 123 GH;US(3), or GEOG 130 GS(3);

GEOG 120 GS;US;IL(3);

GEOG 122 GH;US(3), GEOG 124 GS;IL(3), or GEOG 128 GS;IL(3);

GEOG 124 GS;IL(3), GEOG 128 GS;IL(3) or GEOG 130 GS(3) (Sem: 3-6)

Select 21 credits from the following courses: GEOG 323(3), GEOG 333(3), GEOG 420Y US;IL(3), GEOG 423Y US(3), GEOG 424Y US;IL(3), GEOG 425(3), GEOG 426Y US;IL(3), GEOG 427 US;IL(3), GEOG 428 US(3), GEOG 429 US(3), GEOG 430(3), GEOG 434(3), GEOG 436(3), GEOG 439(3), GEOG 440(3), GEOG 444(3), or GEOG 493(3).

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

[71] The following substitutions are allowed for students attending campuses where the indicated course is not offered: CAS 100 GWS or ENGL 202C GWS can be substituted for EM SC 100S GWS.

Last Revised by the Department: Fall Semester 2006

Blue Sheet Item #: 34-06-196

Review Date: 4/11/06

EM

Publications updated department head: 9/2/08

Geosciences

University Park, College of Earth and Mineral Sciences (GSCBA)

PROFESSOR DAVID M. BICE, *Associate Head for Undergraduate Programs*

The geosciences are concerned with understanding earth processes and the evolutionary history of the Earth. Geoscientists work to discover and develop natural resources such as groundwater, metals, and energy sources; to solve technology-generated environmental problems such as acid mine drainage and waste disposal; to predict geological events, such as the occurrence of earthquakes and volcanism; and to solve fundamental questions concerning the origin and evolution of Earth and life. The Bachelor of Arts degree program stresses data collection; investigation, analysis and synthesis of information related to complex natural problems; rigor of thought and clarity of oral and written expression. The B.A. provides a basic education in geosciences, and is designed for students who wish to prepare themselves for careers that interface among science, social science, and business. Examples of these careers include environmental law, national and international planning or resource management, and K-12 teaching.

For the B.A. degree in Geosciences, a minimum of 120 credits is required.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

GENERAL EDUCATION: 45 credits

(21 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)
(See description of General Education in this bulletin.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES:

(Included in GENERAL EDUCATION course selection or REQUIREMENTS FOR THE MAJOR)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

BACHELOR OF ARTS DEGREE REQUIREMENTS: 24 credits

(3 of these 24 credits are included in the REQUIREMENTS FOR THE MAJOR, GENERAL EDUCATION, or ELECTIVES and 0-12 credits are included in ELECTIVES if foreign language proficiency is demonstrated by examination.)

(See description of Bachelor of Arts Degree Requirements in this bulletin.)

REQUIREMENTS FOR THE MAJOR: 72 credits

(This includes 21 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 6 credits of GWS courses.)

PRESCRIBED COURSES (10 credits)

EM SC 100S GWS(3)[71](#mnote71) (Sem: 1-2)

GEO SC 001(3) [1](#mnote01) [if GEO SC 001 is not available, GEO SC 020 GN(3) may be substituted] (Sem: 1-6)

GEO SC 201(4) [1](#mnote01) (Sem: 3-6)

ADDITIONAL COURSES (48-51 credits)

ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)

MATH 140 GQ(4) or MATH 110 GQ(4) (Sem: 1-2)

GEO SC 310(4) [1](#mnote01) or GEO SC 320(3) [1](#mnote01) (Sem: 3-6)

GEO SC 202(4), GEO SC 203(4), or GEO SC 204(4) (Sem: 5-8)

Select 20 credits--two of the following sequences for 8 credits each and the third sequence for 4 credits:

-BIOL 110 GN(4), BIOL 220W GN(4) (Sem: 1-4)

-CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3), CHEM 113 GN(1) (Sem: 1-4)

-PHYS 250 GN(4), PHYS 251 GN(4) (Sem: 1-4)

Note: PHYS 211 GN(4), PHYS 212 GN(4), PHYS 213 GN(2), PHYS 214 GN(2) may substitute for up to 8 credits in Physics for students with MATH 140 GQ(4), MATH 141 GQ(4).

Select 2-4 credits of advanced mathematics in consultation with an adviser; list includes MATH 111 GQ(2), MATH 141 GQ(4), STAT 200 GQ(4), STAT 250 GQ(3) (Sem: 2-6)

Select 6 credits from 300- and 400-level GEO SC courses (Sem: 5-8)

Select 3 credits of appropriate field/laboratory experience in consultation with adviser (Sem: 6-8)

Select 3 credits of writing-intensive courses from within Earth and Mineral Sciences to include, but not limited to: GEOG 412W(3), GEOG 310W(3), GEO SC 402W(3), GEO SC 470W(3), METEO 471W(3) (Sem: 6-8)

SUPPORTING COURSES AND RELATED AREAS (11-14 credits)

Select 11-14 credits in consultation with adviser.

(Students may apply 6 credits of ROTC) (Sem: 3-8)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

[71] The following substitutions are allowed for students attending campuses where the indicated course is not offered: CAS 100 GWS or ENGL 202C GWS can be substituted for EM SC 100S GWS.

Last Revised by the Department: Summer Session 2000

Blue Sheet Item #: 28-05-014

Review Date: 10/8/02

UCA Revision #1: 8/8/06

Department Head Changed: 4/12/05

EM

Geosciences

University Park, College of Earth and Mineral Sciences (GSCBS)

PROFESSOR DAVID M. BICE, Associate Head for Undergraduate Programs

The geosciences are concerned with understanding earth processes and the evolutionary history of the Earth. Geoscientists work to discover and develop natural resources such as groundwater, metals, and energy sources; to solve technology-generated environmental problems such as acid mine drainage and waste disposal; to predict geological events, such as the occurrence of earthquakes and volcanism; and to solve fundamental questions concerning the origin and evolution of Earth and life. Our degree programs stress data collection; investigation, analysis and synthesis of information related to complex natural problems; and rigor of thought and clarity of oral and written expression. The B.S. provides a broad foundation in the physical and natural sciences for students who seek immediate employment or post-graduate education in several areas of the geosciences. Examples of careers include the petroleum and mining industries; local or federal resource management; water resources, treatment and management; energy and environmental industries; and academia. A senior thesis involving independent research is required of all students.

GENERAL OPTION: This option is designed to provide sufficient flexibility so that the student has the opportunity to prepare for graduate school by focusing on specialized areas in the geosciences. The option's flexibility also permits students to develop a broad background in the geosciences in preparation for post-graduate majors that require breadth, such as environmental law.

HYDROGEOLOGY OPTION: This option helps prepare the student for entry-level positions in environmental agencies and firms where a specialized knowledge of groundwater and related areas is required. The option is also appropriate for students wishing to pursue an advanced degree in the area of hydrogeology.

For the B.S. degree in Geosciences, a minimum of 121 credits is required.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

GENERAL EDUCATION: 45 credits
(21 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)
(See description of General Education in this bulletin.)

FIRST-YEAR SEMINAR:
(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES:
(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:
(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR : 97 credits
(This includes 21 credits of General Education courses: 9 credits of GN courses, 6 credits of GQ courses, 6 credits of GWS courses.)

COMMON REQUIREMENTS FOR THE MAJOR (ALL OPTIONS): 69 credits

PRESCRIBED COURSES (66 credits)
BIOL 110 GN(4), EM SC 100S GWS(3) [\[71\]\(#mnote71\)](#), MATH 140 GQ(4), MATH 141 GQ(4) (Sem: 1-2)
CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3), CHEM 113 GN(1), PHYS 211 GN(4), PHYS 213 GN(2) (Sem: 1-4)
GEOSC 001(3) [if GEOSC 001 is not available, GEOSC 020 GN(3) may be substituted] (Sem: 1-6)
GEOSC 201(4) [\[11\]\(#mnote01\)](#), GEOSC 202(4) [\[11\]\(#mnote01\)](#), GEOSC 204(4) (Sem: 3-6)

GEOSC 203(4) [\[1\]\(#mnote01\)](#), GEOSC 310(4) [\[1\]\(#mnote01\)](#), GEOSC 465(4) [\[1\]\(#mnote01\)](#),
GEOSC 472A(3), GEOSC 472B(3) (Sem: 5-6)
GEOSC 494W(3), GEOSC 496(1) (Sem: 7-8)

ADDITIONAL COURSES (3 credits)

ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)

REQUIREMENTS FOR THE OPTION : 28 credits

GENERAL OPTION: (28 credits)

ADDITIONAL COURSES (14 credits)

Select 14 credits from 300- and 400-level GEOSC courses: GEOSC 303(3), GEOSC 340(3), GEOSC 402(3), GEOSC 416(3), GEOSC 421(3), GEOSC 422(3), GEOSC 423(4), GEOSC 424(3), GEOSC 426(3), GEOSC 434(3), GEOSC 439(3), GEOSC 440(3), GEOSC 451(3), GEOSC 452(3), GEOSC 454(3), GEOSC 461(3), GEOSC 470W(3), GEOSC 471(3), GEOSC 489(4) (Sem: 5-8)

SUPPORTING COURSES AND RELATED AREAS (14 credits)

Select at least 2 credits in physics from approved departmental list (Sem: 1-4)

Select 3 credits of computer science, mathematics [above the level of MATH 141 GQ(4)], or statistics (Sem: 3-6)

Select 9 credits, in consultation with adviser, supportive of the student's interest (Students may apply 6 credits of ROTC.) (Sem: 3-8)

HYDROGEOLOGY OPTION : (28 credits)

PRESCRIBED COURSE (3 credits)

GEOSC 452(3) (Sem: 5-8)

ADDITIONAL COURSES (15 credits)

Select 3 credits from CMPSC 201 GQ(3), CMPSC 202 GQ(3), CMPSC 203 GQ(4), STAT 250 GQ(3) [if STAT 250 is not available, STAT 200 GQ(4) may be substituted] (Sem: 3-8)

Select 3 credits from A S M 327(3), E R M 450(3), SOILS 101 GN(3), SOILS 415(3) (Sem: 5-8)

Select 9 credits from A and B. Students must select at least 3 credits from A and 3 credits from B.
A. CHEM 202(3), CHEM 450(3), E R M 433(3), GEOSC 413W(3), GEOSC 419(3) (Sem: 3-8)

B. GEOEE 408(3), GEOG 362(3), GEOSC 340(3), GEOSC 439(3), GEOSC 454(3), GEOSC 483(3) (Sem: 5-8)

SUPPORTING COURSES AND RELATED AREAS (10 credits)

Select at least 2 credits in Physics from approved departmental list (Sem: 1-4)

Select 8 credits, in consultation with advisor, supportive of the student's interest. (Students may apply 6 credits of ROTC) (Sem: 3-8)

Integrated B.S./M.S. Program in Geosciences

The Department of Geosciences offers an integrated B.S./MS. Program that is designed to allow academically superior students to obtain both the B.S. and the M.S. degree in Geosciences within 5 years of study. Students who wish to complete the Integrated B.S./M.S. Program in Geosciences must apply for admission to the Graduate School and the Integrated B.S/M.S program by the end of their junior year.

During the first three years, the student follows the course scheduling of one of the options in Geosciences; however, if a student intends to enter the Integrated B.S./M.S. program, he/she would be encouraged to take, wherever appropriate, upper level classes. By the end of the junior year, the student normally would apply for admission to the program. A decision of acceptance would be made prior to the beginning of the senior year and a M.S. Advising Committee appointed. During the senior year, the student would follow the scheduling of the B.S. Geosciences option he/she has selected, with an emphasis on completing 500-level coursework wherever appropriate. In place of the Senior Thesis, the student will complete a M.S. Thesis

During the fifth year the student will take courses fulfilling the departmental M.S. degree requirements and complete the M.S. Thesis.

Admissions Requirements

Students who wish to complete the Integrated B.S./M.S. Program in Geosciences must apply for admission to the Graduate School and the Integrated B.S./M.S program by the end of their junior year. Typical tests scores of students admitted to the Geosciences Graduate Program are: GPA 3.5, and GRE's Verbal 570 and Quantitative 700. Three letters of recommendation by faculty members for admission to graduate studies are required. The applications are reviewed by the Admissions Committee of the Geosciences Graduate Program and acted upon by the Associate Head for Graduate Programs.

The details of the program requirements can be found in the *Graduate Degree Programs Bulletin*.

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

[71] The following substitutions are allowed for students attending campuses where the indicated course is not offered: CAS 100 GWS or ENGL 202C GWS can be substituted for EM SC 100S GWS.

Last Revised by the Department: Summer Session 2008 (GSCBS); Summer Session 2005 (Integrated B.S./M.S.)

Blue Sheet Item #: 36-04-026 (GSCBS); 33-04-165 (Integrated B.S./M.S.)

Review Date: 1/15/08

UCA Revision #1: 8/8/06

UCA Revision #2: 7/27/07

EM

**PROGRAM CURRENTLY ON HOLD;
NOT ACCEPTING NEW STUDENTS
Begin Date of Enrollment Hold: March 5, 2009**

Industrial Health and Safety

University Park, College of Earth and Mineral Sciences (I H S)

PROFESSOR JOEL M. HAIGHT, *Undergraduate Program Officer*

The B.S. program in Industrial Health and Safety is accredited by the Applied Science Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone: 410-347-7700. This program is designed to provide students with the technical and managerial skills necessary to address the occupational health and safety concerns associated with the extraction and utilization activities of the minerals and fuels industries, the construction industry, and other heavy industries. Employers in the United States are mandated by federal and state laws to provide workplaces that are free of recognized hazards to personnel. Agencies such as OSHA and MSHA have placed increased emphasis on employer responsibilities for the health and safety of their employees. Annually, work-related incidents cost the United States in excess of \$40 billion, affecting not only workman's compensation but also reducing productivity. This program includes a general background in the basic sciences, followed by a core program emphasizing the nature of the various industries, as well as the economic, technical, and policy issues of occupational health and safety.

For the B.S. degree in Industrial Health and Safety, a minimum of 129 credits is required.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

GENERAL EDUCATION: 45 credits

(24 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in this bulletin.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES:

(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 108 credits

(This includes 24 credits of General Education courses; 6 credits of GWS courses; 6 credits of GQ courses; 9 credits of GN courses; and 3 credits of GS courses.)

PRESCRIBED COURSES (86 credits)

BIOL 141 GN(3)[1](#mnote01), BIOL 142(1), CHEM 110 GN(3)[1](#mnote01), CHEM 111 GN(1)[1](#mnote01), CHEM 202(3), CMPSC 203 GQ(4), EM SC 100S GWS(3)[71](#mnote71), MATH 140 GQ(4), MATH 141 GQ(4), PSYCH 100 GS(3) (Sem: 1-2)
E MCH 210(5), E MCH 212(3), MGMT 100(3), PHYS 211 GN(4), PHYS 212 GN(4) (Sem: 3-4)
I E 327(3), I H S 400(3)[1](#mnote01), I H S 410(3), I H S 420(3), I H S 447(4), I H S 430(3)[1](#mnote01), I H S 440(3), I H S 445(3) (Sem: 5-6)
I H S 450(3), I H S 470(3), I H S 490(1), I H S 495W(6) (Sem: 7-8)

ADDITIONAL COURSES (7 credits)

ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)

SCM 200(4) or STAT 200 GQ(4) (Sem: 3-4)

SUPPORTING COURSES AND RELATED AREAS (15 credits)

Select 3 credits from the I H S course list of industrial or manufacturing processes (Sem: 5-6)

Select 12 credits from the I H S-approved list, in consultation with adviser, supportive of the student's interests. (Students may apply 6 credits of ROTC.) (Sem: 7-8)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

[71] The following substitutions are allowed for students attending campuses where the indicated course is not offered: CAS 100 GWS or ENGL 202C GWS can be substituted for EM SC 100S GWS.

Last Revised by the Department: Summer Session 2004

Blue Sheet Item #: 32-01-047

Review Date: 1/21/05

UCA Revision #1: 8/8/06

EM

Liberal Arts and Earth and Mineral Sciences Concurrent Degree Program

Liberal Arts and Engineering Concurrent Degree Program

ASSOCIATE DEAN JOHN L. SELZER, *in charge*

These programs require ten semesters of study, concurrently in the College of the Liberal Arts (during which the student completes 70 credits in General Education and Bachelor of Arts requirements and 33 to 37 basic engineering or science requirements), and in either the College of Earth and Mineral Sciences or the College of Engineering (during which the student completes the credits required in the selected major in Earth and Mineral Sciences or Engineering).

Upon completion of the program, the B.A. in General Arts and Sciences will be awarded by the College of the Liberal Arts and the B.S. by the College of Earth and Mineral Sciences or the College of Engineering. The majors available in the College of Earth and Mineral Sciences are Environmental Systems Engineering, Geosciences, Mining Engineering, Polymer Science, Mineral Economics, Petroleum and Natural Gas Engineering, Ceramic Science and Engineering, Metals Science and Engineering, or Meteorology. The majors available in the College of Engineering are Aerospace, Agricultural, Chemical, Civil, Electrical, Environmental, Industrial and Management Systems, Mechanical, or Nuclear Engineering, or Engineering Science. [\[44\]\(#mnote44\)](#)

To be eligible for this program, a student must file an application for entrance with the associate dean for undergraduate studies, College of the Liberal Arts, not later than the third semester. Entrance to the program requires that the student satisfy all regular requirements of the College of the Liberal Arts and the College of Earth and Mineral Sciences or the College of Engineering. In addition, special requirements may need to be satisfied when enrollment controls are imposed on programs in any of the colleges because of space limitations. Once a student has met all the requirements for entrance to this program, transfer from the College of the Liberal Arts to the College of Earth and Mineral Sciences or the College of Engineering, with enrollment in one of the majors listed, will be approved automatically at the end of the sixth semester if the student continues to make normal progress toward the concurrent degree and has maintained a cumulative average of 2.00 or higher. Students entering majors in the College of Engineering must complete the following courses with a grade of C or higher: CHEM 110 GN(3) and CHEM 111 GN(1), MATH 140 GQ(4), MATH 141 GQ(4), and PHYS 201 GN(4), and meet the required cumulative grade-point average for the requested engineering major.

Students are advised of the absolute necessity for scheduling classes in exact sequence during the first six semesters of Concurrent Degree study. It is imperative that students obtain, from the Liberal Arts Undergraduate Studies Office, 101 Sparks Building, a copy of the Concurrent Degree requirements worksheet that enumerates the specific course requirements for the two programs for semesters one through six.

Scheduling Recommendation by Semester Standing given like (Sem:1-2)

GENERAL EDUCATION: 45 credits

(15 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)
(See description for General Education in this bulletin.)

FIRST-YEAR SEMINAR:

(Included in GENERAL EDUCATION course selection or REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES:

(Included in GENERAL EDUCATION course selection or REQUIREMENTS FOR THE MAJOR)

WRITING ACROSS THE CURRICULUM:

(Included in GENERAL EDUCATION course selection or REQUIREMENTS FOR THE MAJOR)

BACHELOR OF ARTS DEGREE REQUIREMENTS: 24 credits

(3 of these 24 credits are included in the REQUIREMENTS FOR THE MAJOR, GENERAL EDUCATION, or ELECTIVES and 0-12 credits are included in ELECTIVES if foreign language proficiency is demonstrated by examination.)

(See description of Bachelor of Arts Degree Requirements in this bulletin.)

REQUIREMENTS FOR THE MAJOR : 12 credits

EARTH AND MINERAL SCIENCES OR ENGINEERING COMPONENT : 89-91 credits

(This includes 15 credits of General Education courses: 6 credits of GQ courses and 9 credits of GN courses.)

SEMESTERS ONE THROUGH SIX (33-34 credits) [\[45\]\(#mnote45\)](#)

PRESCRIBED COURSES (27 credits)

CHEM 111 GN(1), CHEM 113 GN(1), MATH 220 GQ(2-3), MATH 230(4), MATH 250(3) (Sem: 1-4)

E G 010(1), E G 011(1) (Sem: 3-4)

PHYS 201 GN(4), PHYS 202 GN(4) (Sem: 3-6)

E MCH 211(3), E MCH 212(3) (Sem: 5-8)

ADDITIONAL COURSES (6-7 credits)

PHYS 203 GN(3) or PHYS 204 GN(4) (Sem: 3-6)

B.S. requirements [\[46\]\(#mnote46\)](#) (3) (Sem: 5-6)**SEMESTERS SEVEN THROUGH TEN** (56-57 credits)

Credits required in the selected major in Earth and Mineral Sciences or Engineering (56-57) (Sem: 7-10)

SUPPORTING COURSES AND RELATED AREAS (12 credits)

Select 3 credits from each of the following areas: arts, humanities, science/mathematics, social and behavioral sciences. (Sem: 9-10)

[44] Enrollment in the Engineering Science program is limited to those students attaining an average of B or higher during their first six semesters and to those specially chosen by the College of Engineering faculty on the basis of evidence that they will benefit from the advanced courses.

[45] Concurrent Degree candidates should consult the individual program requirements in the College of Engineering and the College of Earth and Mineral Sciences to ascertain which combinations of CHEM, E G, E MCH, MATH, and PHYS are required.

[46] Concurrent Degree candidates should select a course in this category appropriate for the requirements for their program in either Earth and Mineral Sciences or Engineering.

Last Revised by the Department: Summer Session 1991

Blue Sheet Item #: 16-10-030

Review Date: 5/22/08

UCA Revision #1: 8/8/06

Materials Science and Engineering

*University Park, College of Earth and Mineral Sciences (MATSE)*PROFESSOR GARY L. MESSING, *Head, Department of Materials Science and Engineering*PROFESSOR R. ALLEN KIMEL, *Associate Head of Undergraduate Studies, Materials Science and Engineering*

The future can be appropriately termed the age of materials. In addition to the traditional engineering applications of metals, ceramics, semiconductors, and polymers, new materials and composites must be developed by materials scientists to aid progress in communications, computing, electronics, biomedicine, transportation, aerospace, defense, and the production and efficient use of energy.

Our curriculum is structured to support our Department mission of providing students with a well-rounded engineering education, with specific emphasis on materials science and engineering in order to meet the needs of industry, academia, and government; to conduct research at the frontiers of the field; and to provide an integrating and leadership role to the broad multi-disciplinary materials community.

The general objective of the undergraduate program is embedded in our mission statement. The Department expects its graduates will apply their knowledge of materials science to the synthesis, design, characterization, and engineering of new materials, and devices comprised of them, in industrial and laboratory settings. Our graduates will have the necessary skills and knowledge to excel in careers related to the entire life-cycle of materials, from raw materials production, to materials synthesis and processing, component design and development, manufacturing, use, reclamation, and recycling.

We expect that our graduates will practice in a wide range of materials-related positions, such as process and manufacturing engineers, technical sales representatives, quality control engineers, research engineers, metallurgists, ceramists, production and plant managers, consultants, etc. In addition, we expect that a substantial portion of our graduates will pursue graduate studies in

technical and business-related disciplines, as well as participate in continuing education activities such as technical symposia, workshops, and short courses.

The educational objectives of the undergraduate program are embedded into our mission statement. We will provide and maintain a curriculum that will prepare our recent graduates to accomplish the following Program Educational Objectives:

1. Our graduates provide science and engineering leadership in international industrial, governmental, and academic settings, while serving both their profession and the public.
2. Our graduates are innovators in a wide variety of technical fields including, but not limited to, materials, energy, electronics, medicine, communications, transportation, and recreation.
3. Our graduates excel in careers related to the entire life cycle of materials, from synthesis and processing, through design and development, to manufacturing, performance, reclamation, and recycling.
4. Our graduates engage in lifelong learning activities which enhance their careers and provide flexibility to respond to changing professional and societal needs.

To achieve these objectives, students in Materials Sciences and Engineering begin with a background in basic chemistry, mathematics, and physics, which are the foundation for broad-based materials properties, processing, and applications courses. Commencing with their junior year, students take courses in Materials Science and Engineering and specialized courses in one of four options: Ceramic Science and Engineering, Electronic and Photonic Materials, Metals Science and Engineering, or Polymer Science and Engineering. The curricula integrate classroom instruction and laboratory experience, and culminate in a capstone research and design experience which is documented in the form of a thesis in the senior year.

The curricula for each of the options in Materials Science and Engineering are described in the following sections.

CERAMIC SCIENCE AND ENGINEERING OPTION

PROFESSOR DAVID J. GREEN, *Option Adviser*

This option covers the manufacture and usage of a wide variety of inorganic materials that usually include high temperatures. The program helps prepare students for operating, research, and development positions in all sections of the ceramic industry and for graduate studies. Graduates also find employment in many other industries that use ceramic materials, such as iron and steel, electrical and electronic, energy generation, automotive, aeronautical, and aerospace. Many find employment in industries that manufacture composite materials such as glass-ceramics, metal-ceramics, or glass-metal structures. The B.S. degree in this option is accredited by the Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012, telephone: 410.347.7700 or www.abet.org (<http://www.abet.org>).

For the B.S. degree in Materials Science and Engineering with an option in Ceramic Science and Engineering, a minimum of 127 credits is required.

ELECTRONIC AND PHOTONIC MATERIALS OPTION

PROFESSOR SUZANNE E. MOHNEY, *Option Adviser*

This option provides specialized courses dealing with the processing, properties, and performance of semiconductor, optoelectronic, and optical materials and devices. The graduates contribute in the electronics, telecommunications, and computer industries or pursue advanced studies in materials science and engineering. The B.S. degree in this option is accredited by the Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012, telephone: 410.347.7700 or www.abet.org (<http://www.abet.org>).

For the B.S. degree in Materials Science and Engineering with an option in Electronic and Photonic Materials, a minimum of 127 credits is required.

METALS SCIENCE AND ENGINEERING OPTION

PROFESSOR PAUL HOWELL, *Option Adviser*

The metals option provides an opportunity to explore a broad range of both scientific and

engineering principles as applied to metals and alloys. A graduate of this option will thus typically apply basic concepts of chemistry, physics, or engineering science to problems concerning the processing or properties of metals. Although metallurgists are often employed by metals-producing industries, an increasingly large fraction are finding employment in a diverse group of industries that use metals, such as those in the electronics or aerospace fields. Many graduates pursue advanced studies. The B.S. degree in this option is accredited by the Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012, telephone: 410.347.7700 or www.abet.org (<http://www.abet.org>).

For the B.S. degree in Materials Science and Engineering with an option in Metals Science and Engineering, a minimum of 127 credits is required.

POLYMER SCIENCE AND ENGINEERING OPTION

PROFESSOR PAUL PAINTER, *Option Adviser*

This option allows the student to establish a firm foundation in the basic sciences and to apply this knowledge to a study of the synthesis, structure, and physical properties of synthetic and natural polymers.

Polymers are a major class of materials consisting of macromolecules of very high molecular weight. Polymers are pervasive in today's technological society and find numerous applications in such diverse fields as plastics, elastomers (rubber), adhesives, surface coatings (paints), biomaterials, textiles, paper, packaging, and composite materials.

This option helps prepare graduates for research, development, and technical sales positions in numerous materials and chemical industries that either produce or utilize polymers; or to proceed to advanced studies in polymer science or related technical fields. The B.S. degree in this option is accredited by the Engineering Accreditation Commission of ABET, Inc., 111 Market Place, Suite 1050, Baltimore, MD 21202-4012, telephone: 410.347.7700 or www.abet.org (<http://www.abet.org>).

For the B.S. degree in Materials Science and Engineering with an option in Polymer Science and Engineering, a minimum of 127 credits is required.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

GENERAL EDUCATION 45 credits

(24 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in front of *Bulletin*. Note The Accreditation Board for Engineering and Technology (ABET) does not permit the use of skills courses to satisfy the Arts category of General Education.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES:

(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 106 credits

(This includes 24 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 9 credits of GWS courses.)

COMMON REQUIREMENTS FOR THE MAJOR (ALL OPTIONS): 66 credits

PRESCRIBED COURSES (59 credits)

CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3), CHEM 113 GN(1), EM SC 100S GWS(3) [\[71\]\(#mnote71\)](#), ENGL 202C GWS(3), MATH 140 GQ(4), MATH 141 GQ(4), MATH 220 GQ(2-3), MATH 231(2), MATH 251(4), PHYS 211 GN(4), PHYS 212 GN(4), PHYS 214 GN(2) (Sem: 1-4)

I E 424(3), MATSE 201(3) [\[11\]\(#mnote01\)](#), MATSE 401(3) [\[11\]\(#mnote01\)](#), MATSE 436(3), MATSE 460(1), MATSE 462(1), MATSE 492W(3) [\[11\]\(#mnote01\)](#), MATSE 494W(2) (Sem: 5-8)

ADDITIONAL COURSES (6 credits)

CMPSC 201 GQ(3) or CMPSC 202 GQ(3), ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-4)

REQUIREMENTS FOR THE OPTION: 40 credits

CERAMIC SCIENCE AND ENGINEERING OPTION: (40 credits)

PRESCRIBED COURSES (31 credits)

E MCH 211(3) (Sem: 4)

MATSE 400(3)[\[1\]\(#mnote01\)](#), MATSE 402(3)[\[1\]\(#mnote01\)](#), MATSE 410(3), MATSE 411(3), MATSE 412(3), MATSE 413(3), MATSE 417(3), MATSE 430(3), MATSE 435(3), MATSE 468(1) (Sem: 5-8)

SUPPORTING COURSES AND RELATED AREAS (9 credits)

Select 9 credits of technical electives in consultation with adviser (Students may apply 6 credits of ROTC and/or 3 credits of Cooperative Education Experience (ENGR X95 or SC X95)) (Sem: 5-8)

ELECTRONIC AND PHOTONIC MATERIALS OPTION: (40 credits)

PRESCRIBED COURSES (28 credits)

E SC 314(3), E E 441(3), MATSE 400(3)[\[1\]\(#mnote01\)](#), MATSE 402(3)[\[1\]\(#mnote01\)](#), MATSE 417(3), MATSE 430(3)[\[1\]\(#mnote01\)](#), MATSE 435(3), MATSE 450(3), MATSE 455(3), MATSE 463(1) (Sem: 5-8)

ADDITIONAL COURSES (3 credits)

MATSE 413(3) or PHYS 237(3) (Sem: 5-8)

SUPPORTING COURSES AND RELATED AREAS (9 credits)

Select 9 credits of technical electives in consultation with adviser (Students may apply 6 credits of ROTC and/or 3 credits of Cooperative Education Experience (ENGR X95 or SC X95)) (Sem: 5-8)

METALS SCIENCE AND ENGINEERING OPTION: (40 credits)

PRESCRIBED COURSES (34 credits)

E MCH 210(5) (Sem: 4)

MATSE 400(3), MATSE 402(3)[\[1\]\(#mnote01\)](#), MATSE 410(3)[\[1\]\(#mnote01\)](#), MATSE 417(3), MATSE 421(3), MATSE 422(3), MATSE 425(3), MATSE 426(3), MATSE 430(3)[\[1\]\(#mnote01\)](#), MATSE 471(1), MATSE 472(1) (Sem: 5-8)

SUPPORTING COURSES AND RELATED AREAS (6 credits)

Select 6 credits of technical electives in consultation with advisor. At least 3 credits must be in MATSE and 3 credits must be in the engineering sciences. (Students may apply 6 credits of ROTC and/or 3 credits of Cooperative Education Experience (ENGR X95 or SC X95)) (Sem: 5-8)

POLYMER SCIENCE AND ENGINEERING OPTION: (40 credits)

PRESCRIBED COURSES (31 credits)

CHEM 210(3), CHEM 212(3), CHEM 213(2) (Sem: 3-4)

MATSE 441(3)[\[1\]\(#mnote01\)](#), MATSE 443(3)[\[1\]\(#mnote01\)](#), MATSE 444(3), MATSE 445(3)[\[1\]\(#mnote01\)](#), MATSE 446(3), MATSE 447(3), MATSE 448(3), MATSE 473(1), MATSE 474(1) (Sem: 5-8)

ADDITIONAL COURSES (3 credits)

MATSE 430(3)[\[1\]\(#mnote01\)](#), or a 400 level engineering technical elective (Sem: 5-8)

SUPPORTING COURSES AND RELATED AREAS (6 credits)

Select 6 credits of technical electives in consultation with advisor. At least 3 credits must be in MATSE and 3 credits in the engineering sciences. (Students may apply 6 credits to ROTC and/or 3 credits of Cooperative Education Experience (ENGR X95 or SC X95)) (Sem: 5-8)

Note: Engineering students are expected to take at least one sequence of humanities, social science, or arts courses of either 6 or 9 credits that culminates in a higher-level course. Humanities, arts, and social science courses should compose an integral part of the engineering program and not be limited to a selection of unrelated introductory courses. Close consultation with advisers on these issues is warranted.

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

[71] The following substitutions are allowed for students attending campuses where the indicated course is not offered: CAS 100 GWS or ENGL 202C GWS can be substituted for EM SC 100S GWS.

Last Revised by the Department: Spring Semester 2009

Blue Sheet Item #: 37-05-026

Review Date: 2/24/09

UCA Revision #1: 8/9/06

UCA Revision #2: 7/30/07

EM

Meteorology

University Park, College of Earth and Mineral Sciences (METEO)

PROFESSOR WILLIAM H. BRUNE, *Head of the Department*

Meteorology is a rigorous scientific discipline devoted to the attainment of an increased understanding of the atmosphere and the development of methods for applying that knowledge to practical problems. Although this field is usually associated with weather prediction, it also has significance in environmental, energy, agricultural, oceanic, and hydrological sciences. For students wishing to pursue many of these areas, the department offers several options within the major.

The major requires a solid foundation in mathematics and the physical sciences, and it provides a comprehensive survey of the fundamentals of atmospheric science. It has sufficient flexibility to permit intensive advanced study in such related areas as mathematics, earth sciences, or engineering. The department has particular strengths in weather analysis and prediction, including forecast uncertainty and severe weather; physical meteorology, including radar meteorology, instrumentation and atmospheric measurements; and applied areas, including atmospheric diffusion, air pollution chemistry, dynamic meteorology, tropical meteorology, climate, weather risk, and remote sensing.

Graduating meteorologists are prepared for professional employment with industry, private consulting firms, government, and the armed forces or for further study toward graduate degrees normally required for research, university, or management positions.

The freshman and sophomore years are largely devoted to preparatory work in science, mathematics, and the liberal arts. The junior and senior years involve a core of basic courses in applied and theoretical topics and a choice of courses offering specialized training. The courses unique to each option are normally taken in the junior and senior years.

AIR-QUALITY STUDIES OPTION: This option enables students to gain in-depth knowledge of important areas within the air-quality field. Air-quality meteorologists are employed in both the public and private sectors. Public-sector positions include those with local, state, and federal agencies charged with regulatory, enforcement, and research activities. Within the private sector, air-quality meteorologists are employed by consulting firms whose clients are concerned with meeting environmental regulations on emissions of pollutants into the atmosphere or with determining the effects of such emissions. Topics offered in the option include the physical and chemical nature of air pollutants; their sources in industrial processes and human activity; their control at the source; their transport and dispersion through the atmosphere; their interaction with other atmospheric constituents; their removal through cloud processes, fallout, and wet deposition; their effects on ecosystems, materials, and humans; and their economic and societal impacts.

ATMOSPHERIC SCIENCES OPTION: This option challenges students to strengthen and broaden

their understanding of the physics and chemistry of the atmosphere and oceans. It helps prepare them for employment in the diverse field of the atmospheric sciences and for graduate study in the atmospheric or related disciplines. Students are encouraged to participate in undergraduate research projects under the supervision of atmospheric and oceanic scientists in the department.

CLIMATOLOGY OPTION: This option allows students to learn about the earth's climate system, with emphasis on how the atmosphere and ocean interact. Students can choose among courses that focus on tropical regions, planetary atmospheres, remote sensing, long-term climate change, human dimensions, the biosphere, and statistical methods used in climate science, as well as on their own independent research.

ENVIRONMENTAL METEOROLOGY OPTION: Environmental Meteorology prepares the student for understanding the impact of the weather on the environment, which is to say the impacts of air and water on ecosystems at human scales. In order to do this, the option establishes links between atmospheric physics and a variety of environmental disciplines pertaining to land, water, soils, and plants. Depending on his/her interests, the student will select courses in the biological sciences, air or water quality, human dynamics, data analysis and surface microclimate. An important component of this program is an undergraduate research project, in which the student is encouraged to develop a topic that addresses problems related to the environment and society, if possible by interacting with public agencies or groups.

GENERAL OPTION: This option has sufficient flexibility to serve the needs of students who wish to pursue topics chosen broadly from subdisciplines of meteorology or from related areas in consultation with the academic adviser. The General option is appropriate both for students who intend to pursue postgraduate degrees and for students who want to emphasize a topic for which no option exists.

WEATHER FORECASTING AND COMMUNICATIONS OPTION: This option prepares students for careers in which their skills as weather forecasters are effectively used in a variety of ways, from science reporting and television broadcasting to web design and computer-based weather graphics production, and developing innovative applications of weather and climate data to industry.

WEATHER RISK MANAGEMENT OPTION: The option combines study of meteorology and atmospheric sciences with training in risk, finance, and decision-making. Weather affects a wide range of industries, including energy, agriculture, insurance, construction, retail, and transport, among others. Weather and climate variation play central roles in the availability of water resources, the spread of disease, and an array of other processes vital for human welfare. There are, consequently, many organizations that confront risks related to weather, and that have a demand for experts who can help them manage these risks. The option in Weather Risk Management is designed for students who wish to work professionally at this intersection of meteorology and risk management.

For a Meteorology course to serve as a prerequisite for any subsequent prescribed or supporting Meteorology course in the major, a grade of C or better must be earned in the prerequisite course.

For the B.S. degree in Meteorology, a minimum of 121 credits is required.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

GENERAL EDUCATION: 45 credits
(23-26 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)
(See description of General Education in front of *Bulletin*.)

FIRST-YEAR SEMINAR:
(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES:
(Included in ELECTIVES or GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:
(Included in REQUIREMENTS FOR THE MAJOR)

ELECTIVES: 6-8 credits

REQUIREMENTS FOR THE MAJOR: 93-95 credits

(This includes 23-26 credits of General Education courses; 8 credits of GN courses; 6 credits of GQ courses; 0-3 credits of GS courses; 9 credits of GWS courses.)

COMMON REQUIREMENTS FOR THE MAJOR (ALL OPTIONS): 63 credits**PRESCRIBED COURSES** (44 credits)

CHEM 110 GN(3), EM SC 100S GWS(3)[\[71\]\(#mnote71\)](#), MATH 140 GQ(4), MATH 141 GQ(4)[\[1\]\(#mnote01\)](#), PHYS 211 GN(4) (Sem: 1-2)
MATH 251(4), PHYS 212 GN(4) (Sem: 3-4)
METEO 300(4)[\[1\]\(#mnote01\)](#), METEO 411(4)[\[1\]\(#mnote01\)](#), METEO 421(4)[\[1\]\(#mnote01\)](#), METEO 431(3)[\[1\]\(#mnote01\)](#), METEO 440W(3)[\[1\]\(#mnote01\)](#) (Sem: 5-6)

ADDITIONAL COURSES (19 credits)

ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)
CMPSC 101 GQ(3) or CMPSC 200 GQ(3) or CMPSC 201 GQ(3) or CMPSC 202 GQ(3) (Sem: 3-4)
MATH 230(4)[\[1\]\(#mnote01\)](#), or MATH 231(2) [\[1\]\(#mnote01\)](#) and MATH 232(2) [\[1\]\(#mnote01\)](#) (Sem: 3-4)
E B F 472(3) or STAT 301 GQ(3) or STAT 401(3) (Sem: 3-6)
CAS 100 GWS(3) or ENGL 202C GWS(3) (Sem: 3-8)
METEO 101 GN(3)[\[1\]\(#mnote01\)](#), or METEO 200A(1.5)[\[1\]\(#mnote01\)](#) and METEO 200B(1.5)[\[1\]\(#mnote01\)](#), or METEO 201(3)[\[1\]\(#mnote01\)](#) (Sem: 1-5)

REQUIREMENTS FOR THE OPTION: 30-32 credits**AIR-QUALITY STUDIES OPTION:** (30 credits)**PRESCRIBED COURSES** (12 credits)

M E 433(3), METEO 437(3)[\[1\]\(#mnote01\)](#), METEO 454(3)[\[1\]\(#mnote01\)](#), METEO 455(3) (Sem: 6-8)

ADDITIONAL COURSES (18 credits)

Select 3 credits from METEO 473(3)[\[1\]\(#mnote01\)](#) or METEO 474(3)[\[1\]\(#mnote01\)](#) (Sem: 5-8)
Select 15 credits from:
CHEM 112 GN(3) (Sem: 6-8)
ENNEC 484(3), E R M 430(3), F SC 401(3), F SC 422(3), EGEE 470(3), GEOG 363(3), GEOG 430(3), M E 405(3), METEO 422(3), METEO 436(3), STAT 462(3) (Sem: 7-8)

ATMOSPHERIC SCIENCES OPTION: (30-31 credits)**PRESCRIBED COURSES** (3 credits)

METEO 422(3) (Sem: 6-8)

ADDITIONAL COURSES (24-25 credits)

Select 3-6 credits from METEO 473(3)[\[1\]\(#mnote01\)](#) and METEO 474(3)[\[1\]\(#mnote01\)](#) (Sem: 5-8)
Select 6-9 credits from METEO 436(3)[\[1\]\(#mnote01\)](#), METEO 437(3)[\[1\]\(#mnote01\)](#), and METEO 454(3)[\[1\]\(#mnote01\)](#) (Sem: 5-8)
Select 9-16 credits from METEO 414(4), METEO 434(3), METEO 448(3), METEO 451(3), METEO 452(3), METEO 455(3), METEO 465(3), METEO 466(3), METEO 470(3), METEO 471W(3), METEO 472W(3), METEO 475W(3), METEO 477(3), METEO 480W(3) (Up to 9 of these credits in relevant courses in Acoustics, Chemistry, Engineering, Mathematics, and Physics may be substituted with the approval of the student's adviser.) (Sem: 7-8)

SUPPORTING COURSES AND RELATED AREAS (3 credits)

Select 3 credits of W courses or their equivalent in addition to METEO 440W. (Sem: 7-8)

CLIMATOLOGY OPTION: (30 credits)**PRESCRIBED COURSES** (18 credits)

METEO 422(3), METEO 436(3)[\[1\]\(#mnote01\)](#), METEO 437(3)[\[1\]\(#mnote01\)](#), METEO 451(3), METEO 470(3), METEO 473(3) [\[1\]\(#mnote01\)](#) (Sem: 6-8)

ADDITIONAL COURSES (12 credits)

Select 12 credits from GEOG 310W(3), GEOG 412W(3), GEOG 417(3), GEOG 430(3)*, GEOG

438W(3)*, GEOSC 320(3), METEO 452(3), METEO 454(3), METEO 466(3), METEO 472W(3), METEO 474(3), METEO 475W(3) or GEOSC 475W(3), METEO 480W(3)*, METEO 486(3), METEO 496(3)* (Sem: 6-8)

*Research would be climate-related.

ENVIRONMENTAL METEOROLOGY OPTION: (31 credits)

PRESCRIBED COURSES (16 credits) (May apply to General Education)

BIOL 110 GN(4), C E 370(3), GEOG 160 GS(3), METEO 454(3)[\[1\]\(#mnote01\)](#), METEO 480W(3) (Sem: 2-8)

ADDITIONAL COURSES (15 credits) (May apply to General Education)

Select 3 credits from METEO 473(3)[\[1\]\(#mnote01\)](#) or METEO 474(3)[\[1\]\(#mnote01\)](#) (Sem: 5-8)
Select 12 credits from B E 300(3), C E 475(3), E B F 200 GS(3), E R M 430(3), EGEE 470(3), GEOG 323(3), GEOG 362(3), GEOG 363(3), GEOG 313(3), M E 320(3), M E 405(3), M E 433(3), METEO 422(3), METEO 436(3), METEO 437(3), METEO 448(3), METEO 455(3), STAT 462(3), W F S 209 GN(3) (Sem: 2-8)

GENERAL OPTION: (30 credits)

ADDITIONAL COURSES (6 credits)

Select 3 credits from METEO 436(3)[\[1\]\(#mnote01\)](#) or METEO 437(3)[\[1\]\(#mnote01\)](#) or METEO 454(3)[\[1\]\(#mnote01\)](#) (Sem: 5-8)

Select 3 credits from METEO 473(3)[\[1\]\(#mnote01\)](#) or METEO 474(3)[\[1\]\(#mnote01\)](#) (Sem: 5-8)

SUPPORTING COURSES AND RELATED AREAS (24 credits)

Select 24 credits from 400-level METEO courses and/or 200-, 300-, or 400-level courses from the Colleges of Agricultural Sciences, Earth and Mineral Sciences, Engineering, and/or Science (Sem: 7-8)

WEATHER FORECASTING AND COMMUNICATIONS OPTION: (31-32 credits)

PRESCRIBED COURSES (13 credits)

METEO 481(3), METEO 482(3) (Sem: 5-6)

METEO 414(4), METEO 415(3) (Sem: 6-8)

ADDITIONAL COURSES (18-19 credits)

Select 3 credits from METEO 436(3)[\[1\]\(#mnote01\)](#) or METEO 437(3)[\[1\]\(#mnote01\)](#) (Sem: 5-8)

Select 3-6 credits from METEO 473(3)[\[1\]\(#mnote01\)](#) and METEO 474(3)[\[1\]\(#mnote01\)](#) (Sem: 5-8)

Select 9-13 credits from CAS 211(3) (Sem: 5-8); E E 477(3) or METEO 477(3); ENGL 416(3), GEOSC 402Y IL(3), METEO 412(4), METEO 413(3), METEO 416(3), METEO 418W(3), METEO 422(3), METEO 454(3), METEO 471W(3), METEO 483(3), METEO 484(3), METEO 485(2-3), METEO 486(3), METEO 496(3)* (Sem: 7-8)

*If a weather-forecasting-and-communications related internship

WEATHER RISK MANAGEMENT OPTION: (30-31 credits)

PRESCRIBED COURSES (18 credits) (May apply to General Education)

E B F 200 GS(3) (Sem: 1-2)

EM SC 301(3), E B F 473(3) (Sem: 3-6)

METEO 460(3), METEO 473(3)[\[1\]\(#mnote01\)](#), METEO 474(3)[\[1\]\(#mnote01\)](#) (Sem: 5-8)

ADDITIONAL COURSES (12-13 credits)

Select 3 credits from METEO 436(3)[\[1\]\(#mnote01\)](#), METEO 437(3)[\[1\]\(#mnote01\)](#) or METEO 454(3)[\[1\]\(#mnote01\)](#) ** (Sem: 5-8)

Select 3 credits from E B F 4013) or ENNEC 484(3) (Sem: 6-8)

Select 3 credits from ECON 490(3), STAT 318(3), STAT 319(3), STAT 414(3), STAT 415(3), STAT 460(3) or STAT 462(3) (Sem: 6-8)

Select 3-4 credits from METEO 414(4), METEO 415(3), METEO 416(3), METEO 417(3), METEO 448(3), METEO 452(3), METEO 454(3)*, METEO 455(3), METEO 456(3), METEO 470(3), METEO 476(3). (Sem: 6-8) Substitutions are possible subject to *prior* approval by the option director.

**Preferred choice

*If not used to fill above requirement

Integrated B.S./M.S. Program in Meteorology

The Department of Meteorology offers an integrated B.S./M.S. (IUG) Program that is designed to allow academically superior students to obtain both the B.S. and the M.S. degree in Meteorology in five years of study. In order to complete the program in five years, students interested in the Integrated B.S./M.S. Program in Meteorology must apply for admission to the Graduate School and the Integrated B.S./M.S. Program by the end of their junior year.

During the first three years, the student will follow the course scheduling of one of the options in the B.S. degree, normally the Atmospheric Sciences or the General option (see the Undergraduate *Bulletin*). Students who intend to enter the Integrated B.S./M.S. program are encouraged to take upper level classes during their first three years whenever appropriate. By the end of the junior year, students normally apply for admission to both the IUG program and to the Graduate School. Acceptance decisions will be made prior to the beginning of the senior year and M.S. advising committees appointed for successful applicants. During the senior year, IUG students follow the scheduling of the selected B.S. Meteorology option, with an emphasis on completing 500-level course work as appropriate. During the senior year, IUG students will start work on their theses or papers that are designed to meet the requirements of the M.S. degree in Meteorology. During the fifth year, IUG students take courses fulfilling the departmental M.S. degree requirements and complete their M.S. theses or papers. Typical scheduling plans for students pursuing the General or Atmospheric Sciences options are given on the departmental Web site <http://www.met.psu.edu>. Undergraduate tuition rates will apply as long as the student is an undergraduate, unless the student receives financial support, for example, via an assistantship requiring the payment of graduate tuition.

Admission Requirements

Students who wish to complete the Integrated B.S./M.S. Program in Meteorology should apply for admission to both the Graduate School and the Integrated B.S./M.S. Program by no later than the end of their junior year. In this case, successful students will be admitted formally into the graduate program in Meteorology just prior to their senior year, if their progress has been satisfactory. Admission prior to the senior year is also possible in some unusual circumstances. In all cases, admission to the program will be at the discretion of the Graduate Admissions Officer for the Department of Meteorology, who will determine the necessary criteria for all applicants. These criteria include the setting of the minimum required scores on the GRE and the minimum cumulative GPA for consideration, the receipt of sufficiently strong recommendation letters from three faculty and a strong letter of support from the department head, and the writing of an excellent proposal for a workable research project with a specific adviser; normally, evidence of significant research progress must be provided in the application as well.

The details of the program requirements can be found in the Graduate Degree Programs *Bulletin*.

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

[71] The following substitutions are allowed for students attending campuses where the indicated courses is not offered: CAS 100 GWS or ENGL 202C GWS can be substituted for EM SC 100S GWS.

Last Revised by the Department: Spring Semester 2009

Blue Sheet Item #: 37-02-022

Review Date: 10/7/08

UCA Revision #1: 8/9/06

UCA Revision #2: 7/30/07

[Comments\(http://www.psu.edu/bulletins/bluebook/contact](http://www.psu.edu/bulletins/bluebook/contact)

Mining Engineering

University Park, College of Earth and Mineral Sciences (MNG E)

PROFESSOR R. LARRY GRAYSON, *Undergraduate Program Officer*

The B.S. program in Mining Engineering is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone: 410-347-7700.

The undergraduate curriculum in mining engineering has been designed to enable students to apply the fundamentals necessary to achieve lifelong professional growth. Upon completion of the program, graduates will be able to pursue employment opportunities in both the private and public sectors as mining engineers, or will be able to pursue advanced education.

The courses are sequenced so that an appropriate blend of theory, applications, and project design is achieved. This enables the mining engineering student to appreciate and comprehend that a successful engineering design project requires a sound theoretical foundation, supported by experimentation and good engineering judgment. The program is designed such that the fundamentals of mathematics, earth, and engineering sciences are integrated into traditional mining engineering topics. Design projects, culminating in the capstone design project, are required throughout the curriculum. The proper execution of these projects requires an awareness of acceptable problem-formulation strategies, the testing of alternative design methodologies, feasibility studies, environmental impacts, and overall economic considerations.

Graduates of the program will be prepared to perform in the various steps of mineral extraction, including exploration, evaluation, development, recovery, and processing. The mining engineering faculty is committed to an interactive teaching and learning environment to ensure that the student plays an active role in the learning process. The general education opportunities are sufficiently broad and diverse in nature and scope to enable the student to tailor the educational experience to particular interests, backgrounds, and expected roles in society.

Mining Engineering graduates will be:

1. Employed in mining or related industries or agencies in technical, research, safety, or managerial roles;
2. Qualified and competent to sit for the professional engineer exam;
3. Solving design and project-related problems based on sound, state-of-the-art mining engineering principles and practices;
4. Engaged in solitary assignments and multi-disciplinary teams addressing economic, budgeting, planning, regulatory, labor, safety and health, environmental, legal and ethical issues in mining-related fields;
5. Effective written and oral communicators; and
6. Pursuing continued learning through education, professional training, and participation in professional activities.

STUDENT-TRAINEE PROGRAM : A five-year work-study plan is available to incoming students in Mining Engineering. Alternating periods of employment in industry and schooling at Penn State, the student-trainee obtains the BS degree in five years instead of four, following a rearranged major. Numerous mining and manufacturing companies as well as governmental agencies are cooperating with the University in providing employment during work periods. In addition to earning sufficient funds to finance their education, student-trainees acquire two years of valuable, practical, and professional experience. Additional information can be obtained from the department.

For the B.S. degree in Mining Engineering, a minimum of 130 credits is required.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

GENERAL EDUCATION: 45 credits
(27 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)
(See description of General Education in this bulletin.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES:

(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 112 credits

(This includes 27 credits of General Education courses: 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GS courses; 6 credits of GWS courses; 3 credits of GH courses.)

PRESCRIBED COURSES (83 credits)

CHEM 110 GN(3), CHEM 111 GN(1), EM SC 100S GWS(3)[\[71\]\(#mnote71\)](#) (Sem: 1-2)

ECON 002 GS(3), EDSGN 100(3) (Sem: 1-4)

MATH 140 GQ(4), MATH 141 GQ(4), MATH 250(3), STAT 301 GQ(3) (Sem: 1-6)

E MCH 210(5), GEOSC 071(3)[\[1\]\(#mnote01\)](#), PHYS 211 GN(4), PHYS 212 GN(4), PHYS 213 GN(2) (Sem: 3-4)

MNG 030(2)[\[1\]\(#mnote01\)](#), MNG 402(3), MNG 422(3), MNG 431(3) (Sem: 3-8)

MN PR 301(3)[\[1\]\(#mnote01\)](#), MN PR 413(1)[\[1\]\(#mnote01\)](#), MNG 404(2), MNG 412(3) (Sem: 5-6)

GEOSC 201(4), MNG 023(2), MNG 410(2), MNG 411(2), MNG 441(3)[\[1\]\(#mnote01\)](#), MNG 451W(5)[\[1\]\(#mnote01\)](#) (Sem: 5-8)

ADDITIONAL COURSES (23 credits)

Select 23 credits, one course from each category a, b, c, d, e, f, g, or h:

- a. ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)
- b. PHIL 103 GH(3) or PHIL 106 GH(3) or PHIL 107 GH(3)
or PHIL 233 GH(3)/S T S 233 GH(3) (Sem: 1-4)
- c. CMPSC 201 GQ(3) or CMPSC 202 GQ(3)
- d. MATH 220 GQ(2-3) or MATH 231(2) (Sem: 3-4)
- e. E MCH 212(3) or E MCH 212H(3) (Sem: 3-4)
- f. EME 301(3) or M E 300(3) (Sem: 4-6)
- g. EME 303(3) or C E 360(3) (Sem: 5-6)
- h. MNG 470 or GEOSC 470W (Sem: 7-8)

SUPPORTING COURSES AND RELATED AREAS (6 credits)

Select 6 credits in consultation with adviser (Students may apply 6 credits of ROTC.) (Sem: 5-8)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

[71] The following substitutions are allowed for students attending campuses where the indicated course is not offered: CAS 100 GWS or ENGL 202C GWS can be substituted for EM SC 100S GWS.

Last Revised by the Department: Summer Session 2009

Blue Sheet Item #: 37-06-031

Review Date: 4/14/09

UCA Revision #1: 8/9/06

UCA Revision #2: 7/30/07

EM

Petroleum and Natural Gas Engineering

University Park, College of Earth and Mineral Sciences (PNG E)

PROFESSOR TURGAY ERTEKIN, *Undergraduate Program Officer*

The B.S. program in Petroleum and Natural Gas Engineering is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone: 410-347-7700.

The undergraduate curriculum in petroleum and natural gas engineering has been designed to equip the student with the fundamentals necessary to achieve lifelong professional growth. Graduates are prepared to enter both the private and public sectors as petroleum and natural gas engineers or to pursue further education at the graduate level.

The courses are structured to serve as a melting pot for theory, application to case studies and engineering project design. This enables the student to appreciate and understand that a successful engineering design project requires a sound theoretical foundation, experimentation and engineering judgment. The thrust of the program structure emphasizes the fundamentals of mathematics and earth and engineering sciences and integrates them in application to traditional petroleum and natural gas engineering topics. Design projects are required throughout the curriculum. Execution of these projects requires an amalgamation of problem formulation strategies, testing of alternative design methodologies, feasibility studies, and economic and environmental considerations. Graduates of the program are expected to perform in various facets of the petroleum industry including drilling, production, evaluation, transportation and storage. The petroleum and natural gas engineering faculty and staff are committed to an interactive teaching and learning environment to ensure that the student is an active participant in the learning process. General education opportunities are sufficiently broad and diverse in scope to enable the student to tailor the educational experience to particular interests, background and expected role in society.

Petroleum and Natural Gas Engineering Program Educational Objectives:

1. Our graduates will integrate key science and engineering principles to address the technological challenges of the petroleum and natural gas industry.
2. Our graduates will practice in a broad range of petroleum engineering fields working on teams that create innovative solutions to the most pressing problems of the petroleum and natural gas industry by implementing the ideals of ethical behavior, professionalism, and environmental sensitivity and social awareness.
3. Our graduates will be recognized as critical and independent thinkers and will assume positions of leadership in defining the social, intellectual, business and technical dimensions of the professional organizations they belong to.
4. Our graduates will continue their life-long learning process and participate in graduate education to remain as effective professionals in the workplace of the future.

For the B.S. degree in Petroleum and Natural Gas Engineering, a minimum of 129 credits is required.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

GENERAL EDUCATION: 45 credits

(30 of these 45 credits are included in the REQUIREMENTS FOR THE MAJOR)

(See description of General Education in this bulletin.)

FIRST-YEAR SEMINAR:

(Included in REQUIREMENTS FOR THE MAJOR)

UNITED STATES CULTURES AND INTERNATIONAL CULTURES:

(Included in GENERAL EDUCATION course selection)

WRITING ACROSS THE CURRICULUM:

(Included in REQUIREMENTS FOR THE MAJOR)

REQUIREMENTS FOR THE MAJOR: 114 credits

(This includes 30 credits of General Education courses: 3 credits of GH courses; 9 credits of GN courses; 6 credits of GQ courses; 3 credits of GS courses; 9 credits of GWS courses.)

PRESCRIBED COURSES (99 credits)

CHEM 110 GN(3), CHEM 111 GN(1), CHEM 112 GN(3), ECON 002 GS(3), EM SC 100S GWS(3) [\[88\]\(#mnote88\)](#) (Sem: 1-2)

MATH 140 GQ(4), MATH 141 GQ(4), MATH 230(4), MATH 251(4), PHYS 211 GN(4), PHYS 212 GN(4), PHYS 213 GN(2) (Sem: 1-4)
E MCH 210(5)[\[77\]\(#mnote\\$\)](#), E MCH 212(3), GEOSC 001(3) (Sem: 3-4)
EGEE 301(6), GEOSC 454(3), P N G 405(3)[\[1\]\(#mnote01\)](#), P N G 406(1)[\[1\]\(#mnote01\)](#), P N G 410(3)[\[1\]\(#mnote01\)](#), P N G 450(3)[\[1\]\(#mnote01\)](#), P N G 451(1)[\[1\]\(#mnote01\)](#), P N G 475(3)[\[1\]\(#mnote01\)](#), P N G 489(3), P N G 490(1) (Sem: 5-6)
ENGL 202C GWS(3), P N G 420(4), P N G 425(3), P N G 430(3), P N G 440W(3), P N G 480(3), P N G 482(1), P N G 491(1), P N G 492(1) (Sem: 7-8)

ADDITIONAL COURSES (9 credits)

Select 9 credits: one course from categories a, b, and c.

- a. ENGL 015 GWS(3) or ENGL 030 GWS(3) (Sem: 1-2)
- b. PHIL 103 GH(3), PHIL 106 GH(3), PHIL 107 GH(3), or PHIL 233 GH(3) (Sem: 3-4)
- c. CMPSC 201 GQ(3) or CMPSC 202 GQ(3) (Sem: 5-6)

SUPPORTING COURSES AND RELATED AREAS (6 credits)

Select 6 credits in consultation with adviser (Students may apply 6 credits of ROTC.) (Sem: 7-8)

[1] A student enrolled in this major must receive a grade of C or better, as specified in Senate Policy 82-44.

[77] Students at branch campuses and/or transfer students can substitute the combination of E MCH 211 and E MCH 213.

[88] The following substitutions are allowed for students attending campuses where the indicated course is not offered: CAS 100 GWS can be substituted for EM SC 100S GWS.

Last Revised by the Department: Spring Semester 2009

Blue Sheet Item #: 37-05-028

Review Date: 2/24/09

UCA Revision #1: 8/9/06

UCA Revision #2: 7/30/07

EM

Associate Degrees

Minors

Climatology Minor

University Park, College of Earth and Mineral Sciences (CLIMA)

PROFESSOR ANDREW M. CARLETON, *in charge*

Climate is a central component of the physical environment, playing an important role in a wide range of human activities. The ability to force changes in the global climate system may be one of the more significant ways in which human society will impact Earth's physical environment in the near future. The climatology minor in the College of Earth and Mineral Sciences is an interdisciplinary program drawing from the fields of Meteorology, Geography, and Geosciences. The minor provides an overview of the physical processes that control present-day climate. It also provides an introduction to the history of climate change through geologic time, and presents some of the causes and consequences of potential future climate change and variability.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits

ADDITIONAL COURSES (18 credits)

Select 18 credits from:

EARTH 103 GN(3) (Sem: 1-8)

GEOG 438W(3), GEOG 412W(3), GEOG 310W(3), GEOG 417(3), GEOSC 320(3), METEO 300(3) (Sem: 5-8)

Last Revised by the Department: Summer Session 2000

Blue Sheet Item #: 28-05-015

Review Date: 8/5/03

EM

Earth Systems Minor

University Park, College of Earth and Mineral Sciences (EASYS)

The recognition that environmental problems are global in extent, and impact on many different components of the Earth System simultaneously, requires that we adopt a large-scale and interdisciplinary approach to questions of global change and the interactions of the physical and human environments. The Earth Systems minor follows such an approach and offers undergraduates the opportunity to study the Earth as an integrated system. The Earth Systems minor is a science minor offered through the College of Earth and Mineral Sciences. It provides a wider interdisciplinary perspective for majors in the traditional Earth Science disciplines (geography, geoscience, and meteorology), and provides an introduction to Earth Sciences and a broad exposure to Earth Systems/Environmental Studies for other science and engineering majors. Students may apply up to 6 credits from courses in the major department to satisfy the minor requirements.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENT FOR THE MINOR: 18 credits

PRESCRIBED COURSES (3 credits)

EARTH 002 GN(3) (Sem: 3-6)

ADDITIONAL COURSES (6 credits)

Select 6 credits from EARTH 103 GN(3), EM SC 470W(3-6), GEOG 430(3), GEOSC 310(4), or METEO 300(3) (Sem: 5-8)

SUPPORTING COURSES AND RELATED AREAS (9 credits)

Select 9 credits from the Earth Systems Committee's approved list of courses (Sem: 5-8)

Last Revised by the Department: Spring Semester 2000

Blue Sheet Item #: 28-05-018

Review Date: 2/15/00

EM

Electronic and Photonic Materials Minor

University Park, College of Earth and Mineral Sciences (EPM)

Electronic and photonic materials have greatly changed modern life. Without them, computers, telecommunication systems, compact disc players, video cameras, and all the electronics with which we have become accustomed would not be possible. The study of electronic and photonic materials is a natural bridge between the fields of electrical engineering and material science.

Students in electrical engineering will benefit from this minor because they will better understand the materials with which they will design electronic and photonic devices, such as transistors on a computer chip or semiconductor lasers in a compact disc player. Training in the field of electronic and photonic materials requires study of the processing and characterization of these materials to help engineers develop ways to lower cost and improve performance. This knowledge will help prepare students to enter the semiconductor industry or pursue graduate studies.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits

PRESCRIBED COURSES (6 credits)

MATSE 201(3) (Sem: 1-4)

E E 441(3) (Sem: 5-8)

ADDITIONAL COURSES (12 credits)

Select 3 credits from E SC 314(3) or an approved E E course (Sem: 1-4)

Select 3 credits from MATSE 450(3) or MATSE 455(3) (Sem: 5-8)

Select 6 credits from E E 442(3), E SC 445(3), MATSE 400(3), MATSE 401(3), MATSE 402(3), MATSE 413(3), MATSE 417(3), MATSE 430(3), MATSE 435(3), MATSE 450(3), MATSE 455(3) (Sem: 5-8)

Last Revised by the Department: Spring Semester 2002

Blue Sheet Item #: 29-07-049

Review Date: 01/15/02

UCA Revision #2: 7/27/07

EM

Energy Engineering Minor

University Park, College of Earth and Mineral Sciences (ENENG)

The minor in Energy Engineering is designed to provide students in engineering, science, and energy business and finance (EBF) with additional courses, exposure, and experiences to the principles and applications of energy engineering. Courses available to students include thermal sciences; petroleum and natural gas processing; renewable/sustainable energy; chemistry of fuels; electrochemical, chemical and nuclear energy conversion processes; physical processes in energy engineering; air pollution; and green engineering and environmental compliance. As a result, the selection of this minor can provide additional career options for students in a wide range of offerings at Penn State.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits

ADDITIONAL COURSES (18 credits)

Select 9 credits from the following courses: EGEE 302(3), EGEE 304(3), EGEE 411(3), EGEE 420(3), EGEE 430(3), EME 301(3) (Sem: 5-6)

Select 9 credits from the following courses: EGEE 433(3), EGEE 437(3), EGEE 438(3), EGEE 441(3), EGEE 451(3), EGEE 464W(3), EGEE 470(3), F SC 431(3), F SC 432(3) (Sem: 7-8)

Last Revised by the Department: Fall Semester 2007

Blue Sheet Item #: 35-05-074

Review Date: 3/4/09

EM

Energy, Environmental, and Mineral Economics Minor

University Park, College of Earth and Mineral Sciences (ENNEC)

PROFESSOR ANDREW KLEIT, *in charge*

This minor has a set of courses focusing on economic issues in energy, risk management, and the environment. The field helps prepare students for careers in industry, government, financial institutions, and non-profit organizations dealing with energy and resource issues. The curriculum provides a strong base for further study in business, economics, law, and social science.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits

PRESCRIBED COURSES (15 credits)

E B F 200 GS(3) (Sem: 1-2)

ECON 302(3), E B F 301(3) (Sem: 3-6)

E B F 473(3), ENNEC 484(3) (Sem: 6-8)

ADDITIONAL COURSES (3 credits)

Select 3 credits from GEOG 430(3), GEOG 431(3), GEOG 424(3) (Sem: 6-8)

Last Revised by the Department: Fall Semester 2003

Blue Sheet Item #: 31-04-062

Review Date: 1/14/03

EM

Geographic Information Science Minor

University Park, College of Earth and Mineral Sciences (G I S)

PROFESSOR KARL S. ZIMMERER, *Head*

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits

PRESCRIBED COURSES (3 credits)

GEOG 160 GS(3) (Sem: 3-6)

ADDITIONAL COURSES (15 credits)

Select 6 credits from GEOG 361(3), GEOG 362(3), or GEOG 363(3) (Sem: 3-6)

Select 9 credits (at least 6 credits at the 400-level) from GEOG 323(3), GEOG 485(3), GEOG 461W(3), GEOG 467(3), GEOG 417(3), GEOG 459(3), GEOG 463(3), or GEOG 468(3) (Sem: 5-8)

Last Revised by the Department: Fall Semester 2006

Blue Sheet Item #: 34-06-195

Review Date: 4/11/06

EM

Publications updated department head: 9/2/08

Geography Minor

University Park, College of Earth and Mineral Sciences (GEOG)

PROFESSOR KARL S. ZIMMERER, *Head*

The Geography minor can complement most majors in the social sciences, physical sciences, biological sciences, and technical disciplines. The geography minor is flexible so that students can tailor their course choices to accommodate individual interests. A broadly based approach to selecting minor courses can be appropriate for students whose majors are highly specialized or narrowly focused. Alternatively, students may choose to fulfill geography minor requirements with a particular content emphasis, such as an interest in environmental issues or urban and regional planning. Looking through course choices and talking with geography staff can make earning the geography minor an important enhancement to one's academic program.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits

SUPPORTING COURSES AND RELATED AREAS (18 credits)

In consultation with a geography adviser:

Select 3 credits in physical geography (Sem: 3-6)

Select 3 credits in human geography (Sem: 3-6)

Select 6 credits of additional geography courses (Sem: 3-6)

Select 6 credits of 400-level geography courses (Sem: 5-8)

Last Revised by the Department: Summer Session 2000

Blue Sheet Item #: 28-04-090

Review Date: 11/01

EM

Publications updated department head: 9/2/08

Geosciences Minor

University Park, College of Earth and Mineral Sciences (GEOSC)

PROFESSOR DAVID M. BICE, *Associate Head for Undergraduate Programs*

The Geosciences minor provides a foundation in the physical and material aspects of the solid Earth, as well as an introduction to field techniques and technical writing. Advanced course work should reflect the students' individual interests. Areas of focus include, but are not limited to: earth materials, evolution of the Earth and life, hydrogeology, environmental geology, natural hazards, plate tectonics, geophysics, climate change. The minor consists of 18 credits of course work, some of which are filled through specific courses as indicated below.

A grade of C or better is required in each course in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits

PRESCRIBED COURSES (7 credits)

GEOSC 021 GN(3) (Sem: 1-6)

GEOSC 201(4) (Sem: 3-8)

ADDITIONAL COURSES (6 credits)

Select 3 credits from GEOSC 001(3), GEOSC 020 GN(3), or GEOSC 071(3) (Sem: 1-6)

Select 3 credits from GEOSC 470W(3), EM SC 470W(3-6) (Sem: 5-8)

SUPPORTING COURSES AND RELATED AREAS (5 credits)

Select 5 credits from a number of courses covering a variety of disciplines and fields of interest. Consult with your adviser. At least 3 credits in this category must be taken at the 400 level; the remaining 2 credits may be at the 200 level or above. (Sem: 5-8)

Last Revised by the Department: Summer Session 2002

Blue Sheet Item #: 30-07-082

Review Date: 4/9/02

Department Head Changed: 4/12/05

EM

Global Business Strategies for the Earth, Energy, and Material Industries Minor

University Park: College of Earth and Mineral Sciences and The Smeal College of Business (G B S)

PROFESSOR ANDREW N. KLEIT, *in charge*

The minor in Global Business Strategies for the Earth, Energy, and Materials Industries is a joint offering of the College of Earth and Mineral Sciences and the Smeal College of Business. The minor introduces students to financial, investment, and management concepts applied to private sector organizations whose operation emphasizes the Earth and its environment, the energy and mineral industries, or the development of new and enhanced materials. The minor focuses on the leadership and information strategies characteristic of enterprises that are succeeding in a rapidly integrating global economy.

The minor provides science and engineering students an introduction to basic entrepreneurial and business concepts to help prepare them for success in a changing professional environment. It provides students in the Smeal College an opportunity to focus on business strategies in the Earth resources, environmental, and materials industries. A minimum of 18 credits is required for the minor. A student enrolled in this minor must receive a grade C or better in all courses in the minor. Advising is available through the EMS Student Center (25 Deike Building).

Scheduling Recommendations by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits

PRESCRIBED COURSES (6 credits)

E B F 200 GS(3) (Sem: 3-4)

E B F 401(3) (Sem: 5-8)

ADDITIONAL COURSES (6 credits)

Select 6 credits from category a or b:

a. B A 301(2) and B A 302(2) and B A 304(2) (Sem: 3-8)

b. FIN 100(3) or E B F 301(3); and MGMT 100(3) or E B F 304W(3) (Sem: 3-8)

SUPPORTING COURSES AND RELATED AREAS (6 credits)

Select 6 credits from the approved list of EMS courses. Approved courses are: EM SC 420(3), E B F

473(3), ENNEC 484(3), GEOG 424 US:IL(3), GEOG 430(3), GEOG 431(3), GEOG 444(3), GEOG 493(3), GEOSC 402Y IL(3), GEOSC 454(3), and METEO 473(3), and P N G 489(3) (Sem: 5-8).

Last Revised by the Department: Summer Session 2007

Blue Sheet Item #: 35-04-219

Review Date: 1/16/07

EM/BA

Industrial Health and Safety Minor

University Park, College of Earth and Mineral Sciences (I H S)

The minor in Industrial Health and Safety offers a specialized program for students in many other broad-based majors, such as in engineering or science, who wish to pursue a career in the areas of occupational safety and health or public health. It offers an array of courses, which provide insight into these and other similar professions. It is recommended that students complete CHEM 110 GN(3), MATH 140 GQ(4), and MATH 141 GQ(4) if they wish to pursue this minor.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits

PRESCRIBED COURSES (9 credits)

I H S 400(3), I H S 430(3), and I H S 445(3) (Sem: 5-6)

ADDITIONAL COURSES (9 credits)

Select 9 credits from I H S 410(3), I H S 420(3), I H S 447(4), I H S 440(3), I H S 450(3), or I H S 470(3) (Sem: 7-8)

Last Revised by the Department: Fall Semester 2001

Blue Sheet Item #: 30-02-003

Review Date: 4/8/03

UCA Revision #1: 8/8/06

EM

Information Sciences and Technology for Earth and Mineral Sciences Minor

University Park, College of Earth and Mineral Sciences

University Park, College of Information Sciences and Technology (ISEMS)

Information Systems are a core component of any research, educational or industrial enterprise in the Earth and Materials Sciences. In addition, the science and engineering disciplines represented in the College have a particular focus on numerical modeling and simulation systems, and on the analysis and management of very large data sets. The EMS - IST minor provides students a basic introduction to information sciences and information technology through courses in the core curriculum of the School of Information Sciences and Technology. Students then select from a group of interdisciplinary EMS courses that focus on the particular interests of the College.

Students must apply for entrance to the minor no later than the beginning of their seventh

semester. A one-time tuition surcharge will be applied to all students enrolled in the minor. A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 19 credits

PRESCRIBED COURSES (13 credits)

IST 110 GS(3) (Sem: 1-2)

IST 210(4) (Sem: 3-4)

IST 220(3), GEOG 463(3) (Sem: 5-6)

ADDITIONAL COURSES (6 credits)

Select 6 credits from P N G 430(3), EM SC 468(3), ECEEM 425(3), or METEO 473(3) (Sem:5-8)

Last Revised by the Department: Fall Semester 2000

Blue Sheet Item #: 28-07-048

Review Date: 10/06/05

Meteorology Minor

University Park, College of Earth and Mineral Sciences (METEO)

Students pursuing the 20-credit Meteorology minor seek to broaden their education by specializing in an applied science. As for Meteorology majors, students minoring in Meteorology must have a strong background in Mathematics and Physics. Eleven of the 20 credits come from the three required courses of METEO 300, METEO 421, and METEO 431. The remaining nine credits come from 100-, 200-, 300-, or 400-level METEO courses, at least one of which must be at the 400 level. Completion of the three required courses ensures that students will have the foundational atmospheric science material that they need to register for the remaining nine Meteorology credits. In consultation with a Meteorology adviser, students may choose these elective courses from a variety of sub-specialties, including Air Quality Studies, Atmospheric Dynamics, Atmospheric Physics, Climatology, Computer Applications, and Weather Analysis and Forecasting.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 20 credits

PRESCRIBED COURSES (11 credits)

METEO 300(4), METEO 421(4), METEO 431(3) (Sem. 5-6)

ADDITIONAL COURSES (9 credits)

Select 9 credits of 100-, 200-, 300-, or 400-level Meteorology; at least 3 credits must be at the 400 level. (Sem. 5-8)

Last Revised by the Department: Summer Session 2009

Blue Sheet Item #: 37-04-006A

Review Date: 1/13/09

EM

Mining Engineering Minor

University Park, College of Earth and Mineral Sciences (MNG E)

PROFESSOR R. LARRY GRAYSON, *Undergraduate Program Officer*

The minor in Mining Engineering offers a specialized program for students in many other broad-based, technical majors, such as those in engineering or science. The demand for professionals with the training and skills for a career in the minerals- and energy-recovery profession far exceeds the supply. Mineral exploration and evaluation, mine development, marketing, health and safety, environmental protection, and mine management are all areas of industry employment. It is recommended that students wishing to pursue this minor come from an engineering or science major. As a result, the selection of this minor can provide additional career options for students in a wide range of offerings at Penn State.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits

PRESCRIBED COURSES (18 credits)

MNG 030(2), MNG 404(2), MNG 410(2), MNG 412(3), MNG 422(3), MNG 431(3), and MNG 441(3)
(Sem: 3-8)

Review Date: Fall Semester 1997

EM

Polymer Science Minor

University Park, College of Earth and Mineral Sciences (PLMSC)

PROFESSOR GARY L. MESSING, *Head, Department of Materials Science and Engineering*

The goal of the polymer science minor is to produce graduates who have a first-hand knowledge of the relationships between the synthesis, structure, properties and processing of polymer materials. Students are required to take MATSE 443 (3 credits), which provides a broad overview of the subject, then select 15 credits chosen from a suite of courses that deal with polymer synthesis, microstructure and morphology, properties and processing.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits

PRESCRIBED COURSES (3 credits)

MATSE 443(3) (Sem: 5-8)

ADDITIONAL COURSES (15 credits)

Select 12 credits from MATSE 441(3), MATSE 442(3), MATSE 444(3), MATSE 445(3), and MATSE 446(3) (Sem: 5-8)

Select 3 credits from B M B 474(3), CH E 441(3), E MCH 446(3), MATSE 473(1), MATSE 474(1), MATSE 447(3), MATSE 494W(3), or MATSE 496(1-3) (Sem: 5-8)

Last Revised by the Department: Spring Semester 2002

UCA Revision #1: 9/1/06

EM

Science, Society and the Environment of Africa Minor

University Park: College of Earth and Mineral Sciences (SSEA)

PROFESSOR TANYA FURMAN, *in charge*

The continent of Africa has the greatest accumulation of natural resource wealth of any region of the world, yet its people and societies are among the poorest and least integrated with the global economy. This interdisciplinary minor enables students to integrate fundamental aspects of the social, physical, and technical sciences that have contributed to this paradox. It provides a complement to elective and required coursework in both the humanities and the sciences, including degree programs in Political Sciences, Earth Sciences, Environmental Resource Management, Engineering, and/or African and African-American Studies. Students in this program will learn to apply fundamental concepts from diverse disciplines towards an integrated understanding of African resource management. This minor provides excellent preparation for students planning careers in development, law, international relations, international business, resource management, engineering and the physical sciences. Learning objectives for the minor include excellence in written and oral expression, the ability to collect and interpret data from a diversity of dynamic natural systems, and rigor in scientific thought.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits

ADDITIONAL COURSES (18 credits)

Select 6 credits of Introductory Coursework: AAA S 105 GN;IL(3), AAA S 110 GS;IL(3), AAA S 192 GH;IL(3), EARTH 105 GN;IL(3), E B F 200 GS(3), GEOG 030 GS(3), GEOG 126 GS(3), GEOG 123 GS(3), GEOG 120 GS(3) (Sem: 1-4)

Select 6 credits of Advanced Topical Coursework I: AAA S 403(3), AAA S 440 USI(3), AAA S 443 IL(3), AAA S 454 IL(3), PL SC 454 IL(3) (Sem: 5-8)

Select 6 credits of Advanced Topical Coursework II: EM SC 470W(3-6), F SC 401(3), GEOG 438W(3), GEOG 420W(3), GEOG 444(3), GEOG 424(3) (Sem 5-8)

Last Revised by the Department: Summer Session 2005

Blue Sheet Item #: 33-02-009

Review Date: 10/12/04

EM

Watersheds & Water Resources Minor

University Park, College of Earth and Mineral Sciences (W W R)

PROFESSOR C. GREGORY KNIGHT, Department of Geography, *in charge*

Watersheds are important landscape features that control the biogeochemistry of natural waters. This interdisciplinary minor enables students to learn the fundamental processes governing the transport and chemical evolution of surface and subsurface waters. It provides a complement to elective and required coursework in earth sciences, resource management, wastewater treatment, and/or environmental planning. Students in this program will learn to apply fundamental concepts of chemistry, biology, geoscience, and landscape evolution to processes operating at the watershed scale. Learning objectives for the minor include excellence in written and oral expression, the ability to collect and interpret data from dynamic natural systems, and rigor in scientific thought.

A grade of C or better is required for all courses in the minor.

Scheduling Recommendation by Semester Standing given like (Sem: 1-2)

REQUIREMENTS FOR THE MINOR: 18 credits

ADDITIONAL COURSES (18 credits)

Select 18 credits from the WWR committee's approved list of courses, which includes but is not

limited to courses listed below (at least 6 credits must be taken at the 400 level):

B E 307(2), B E 467(4), A S M 217(3), A S M 327(3), C E 370(3), C E 371(3), C E 461(3), C E 473(3), C E 475(3), CHEM 202(3), CHEM 402(3), E R M 411(3), E R M 432(3), E R M 435(3), E R M 450(3), ENVE 411(3), ENVE 415(3), FOR 470(3), FOR 471(1), GEOEE 408(3), GEOG 431(3), GEOSC 201(4), GEOSC 340(3), GEOSC 412(3), GEOSC 413W(3), GEOSC 419(3), GEOSC 445(4), GEOSC 452(3), METEO 417(3), METEO 448(3), SOILS 405(3), SOILS 415(3), SOILS 418(3), W F S 410(3), W F S 422(3) (Sem: 5-8)

Last Revised by the Department: Summer Session 2008

Blue Sheet Item #: 36-04-027

Review Date: 1/15/08

UCA Revision #1: 8/14/06

EM

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