April 23, 2010

To: Greg Horowitz, Chair, Faculty Council

From: David J. Furbish, Chair, Earth and Environmental Sciences (EES)

Subject: Revision of Requirements for Major and Minor in EES

I endorse the revisions in the EES program that have been forwarded to you by Molly Miller, Director of Undergraduate Studies.

The EES faculty has been discussing changes in the courses required for several years. The revisions reflect hours of work by the entire faculty, and consensus has been reached.
Earth and Environmental Sciences

(Note: The first 3 paragraphs of the EES section are unchanged; the fourth is changed as below.)

For students with primary interests in environmental issues, there are three degree options. A student may major in EES with an Environmental Geoscience Concentration, or may construct an individualized interdisciplinary major. Alternatively, a student may major in another conventional discipline and augment that with an environmental science or environmental studies minor.

Programs of Concentration in Earth and Environmental Sciences

Three programs of concentration are available. Program I (Concentration in Geoscience) provides a background for careers or post-graduate work in related fields such as teaching, law, or business, or, with appropriate supporting sciences and mathematics, for graduate school and some professional positions in the geological sciences. Program II (Concentration in Environmental Geoscience) prepares students for careers or graduate work in environmental geosciences. Program III (Honors) is designed for excellent, highly motivated students who want to pursue research as undergraduates. Course requirements for each concentration are listed below.

I: Geoscience Concentration
II: Environmental Geoscience
III: Honors

101, 111 4 101, 111 4 Course work as for
202 4 202 4 Program I or II 31-33
220W 4 220W 4 292a-292b 4-6
225 4 225 4
226 4 226 4
230 4 230 4
240 4 240 4
299 1 299 1

One additional 200- or _______ One additional 200- or _______
— 300-level course other — 300-level course other
— than 289a-289b — than 289a-289b
— or 291a-291b or 291a-291b

Three options are available within the EES major. All provide a solid grounding in the Earth and environmental sciences. The differences are in requirements for supporting sciences and mathematics and for research. Option I provides a background for careers or post-graduate work in related fields such as teaching, law, or business and for some graduate programs and employment opportunities in Earth and environmental sciences. Option II prepares students well for graduate work and careers in the Earth and environmental sciences. Option III (Honors) is designed for excellent, highly motivated students who want to pursue research as undergraduates.

Required EES courses for Options I and II

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<td>EES 101/111</td>
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<td>EES 102 or 202</td>
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32 hours toward major
Option I. Provides students with a comprehensive background in geoscience. In addition to the courses listed above, students are required to take 1 course each from 2 of the following groups:

Group A: Physical World: Physics I (Physics 116a/118a; 4 hr or Physics 121a; 5 hr)  
Chemistry I (Chemistry 102a/104a; 4 hr)  
Astronomy (201; 3 hr)

Group B: Earth Life: Biological Sciences (100; 4 hr or 110a/111a; 4 hr or 118; 4 hr or 218; 4 hr or 219; 4 hr or 238/237; 4 hr)

Group C: Quantitative Skills: Calculus I (Math 140; 4 hr or 150a; 3 hr or 155a; 4 hr)  
Statistics (Math 127a; 3 hr)

Total hours = 38-41

Program I. Geoscience Concentration. Provides students with a comprehensive background in geoscience. In addition to the courses listed above, students who intend to pursue graduate study or a career in the geological sciences are strongly encouraged to take one year of chemistry, one year of calculus, and one year of physics. (Ecology or evolution may be more appropriate for some students than the second semester of physics.)

Option II. Provides students with most course work needed for a career or graduate studies in geoscience. Students take the required EES courses and complete the following:

Physics I (116a/118a; 4 hr), Chemistry I (102a/104a; 4 hr), and Calculus I (Math 150a; 3 hr or 155a; 4 hr)

Total hours = 43-44

In addition, the second semesters of Chemistry, Physics, and Calculus as well one or more courses in Biological Sciences are highly recommended to complete courses commonly required for graduate school or employment. Recommended selections include:

Physics II (116b/118b; 4 hr) or Chemistry II (102b/104b; 4 hr) or Calculus II (Math 150b; 3 hr or 155b; 4 hr) Biological Sciences (100; 4 hr or 110a/111a; 4 hr or 118 or 218; 4 hr or 219; 4 hr or 238/237; 4 hr) or Astronomy (201; 3 hr)

Program II. Environmental Geoscience Concentration. Provides students with course work needed for a career or graduate studies in environmental science. In addition to the courses
listed above, students must complete supporting work in mathematics and the natural sciences. This includes Biological Sciences 218 or 238 or Physics 116a or 121a (with lab); Chemistry 102a-102b and 104a-104b, one year of calculus, and an additional course approved by the EES faculty in mathematics, engineering, or any of the natural sciences other than EES. A student may petition the EES faculty to substitute an alternative list of courses in mathematics and the natural sciences.

Option III: Honors. Provides research experience as well as thorough course work preparation for a career or graduate studies in earth or environmental sciences. Interested students should apply to the undergraduate adviser for entry into the Honors Program before the end of fall semester, junior year. A minimum of a 3.000 grade point average both overall and in the major is required for entry into the Honors Program. Course work is the same as for Option II with the addition of EES 292a and b (4 hours).

Total hours = 47-48

In addition, the second semesters of Chemistry, Physics, and Calculus as well one or more courses in Biological Sciences are highly recommended to complete courses commonly required for graduate school or employment. Recommended selections include:

Interested students should apply to the undergraduate adviser for entry into the Honors program before the end of fall semester, junior year. A minimum of a 3.000 grade point average both overall and in the major is required for entry into the Honors program.

Working closely with a faculty adviser, students in the Honors Program undertake complete a research project of interest to both the student and faculty member during the senior year. The project is submitted as a senior thesis which is reviewed by two faculty members; it is also presented orally to EES faculty and students during the spring semester. In order to graduate with honors in EES, a student must: (1) maintain a 3.000 average; (2) complete 4 to 6 hours of EES 292a-292b, including a written senior thesis; (3) adequately present the results of his/her research in written form to two members of the faculty and orally to students and faculty of the department; and (4) complete supporting work in mathematics and relevant natural science. This includes Physics 116a or 121a (with lab); Chemistry 102a-102b and 104a-104b, one year of calculus, and an additional course approved by the EES faculty in mathematics, engineering, or any of the natural sciences other than EES. A student may petition the EES faculty to substitute an alternative list of courses in mathematics and the natural sciences. (2) complete the required courses for Option II plus EES 292-292B; (3) satisfactorily present the results of his/her research in written form as a senior thesis to two members of the faculty and orally to students and faculty of the department.

Minor in Earth and Environmental Sciences

The minor in EES provides students with a broad background in earth processes, systems, and history, and an introduction to environmental issues. This background is highly relevant to
many different fields of endeavor. The minor does not, however, prepare students for graduate studies or employment as earth scientists.

The minor consists of at least five courses (16 hours). The minor consists of at least five courses (at least 17 hours; EES 101/111 and 103/113 each count as one course). Although EES 101 (with 111) and 102 103 (with 113) are highly recommended, students are encouraged to choose courses based on their interests and career plans and to discuss course selection with the director of undergraduate studies. No more than two 100-level courses count toward the minor. Two courses with labs are required; one must be at the 200-level. No more than two of the following count towards the minor: 100, 101 (with 111) 103 (with 113). No credit toward the minor is given for EES 289a-289b or 291a-291b.
Earth and Environmental Sciences

(Note: The first 3 paragraphs of the EES section are unchanged; the fourth is changed to the below)

For students with primary interests in environmental issues, there are three degree options. A student may major in EES, or may construct an individualized interdisciplinary major. Alternatively, a student may major in another conventional discipline and augment that with an environmental science or environmental studies minor.

Program of Concentration in Earth and Environmental Sciences

Three options are available within the EES major. All provide a solid grounding in the Earth and environmental sciences. The differences are in requirements for supporting sciences and mathematics and for research. Option I provides a background for careers or post-graduate work in related fields such as teaching, law, or business and for some graduate programs and employment opportunities in Earth and environmental sciences. Option II prepares students well for graduate work and careers in the Earth and environmental sciences. Option III (Honors) is designed for excellent, highly motivated students who want to pursue research as undergraduates.

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<td>EES 240</td>
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Working closely with a faculty adviser, students in the Honors program complete a research project of interest to both the student and faculty member during the senior year. In order to graduate with honors in EES, a student must: (1) maintain a 3.000 average; (2) complete the required courses in EES and related sciences and mathematics, as listed above; (3) satisfactorily present the results of his/her research in written form as a senior thesis to two members of the faculty and orally to students and faculty of the department.

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than two 100-level courses count toward the minor. Two courses with labs are required; one must be at the 200-level. No credit toward the minor is given for EES 289a-289b or 291a-291b.
April 23, 2010

To: Gregg Horowitz, Chair, Faculty Council

From: Molly Miller, Director of Undergraduate Studies, Earth and Environmental Sciences (EES)

Subject: Clarifications of proposed changes in EES major and minor

In this memo (with attachments) we address the following concerns brought up by Council members about the EES revised major requirements:

1) One Council member summed up the concerns of several by writing "It is opaque to me how the rationale EES provides for the revisions to the major motivates the specific revisions."

Another....

2) "In the end, I understand what they [EES] are trying to do, but it is not completely clear while reading through their documentation. Examples of sections that gave me trouble as a reader are given below. I commend EES for trying to be explicit about required courses from outside the department.

1. Programs I, II and III.

I think the part that gave me the most difficulty was under "II. Supporting science and mathematics courses". The second paragraph of this section leads with a sentence that ends with the add-on "..., including Program I." Prior to that point, there had been no mention that there were multiple programs. These programs did not become clear until they were described in detail in the proposed replacement wording for the catalog (and called "Options" at that point instead of "Programs").

2. EES 202.

This course is not mentioned during the first description of the new curriculum near the bottom of page 1, but is then mentioned later as a new required course. This should be mentioned earlier. I'm also a little unclear on the order in which things have been done here. EES is proposing to require this new course 202, but the course itself has not yet been approved (at least not as of the writing of the initial letter, perhaps the course has now been approved). On a related note, the documentation says that EES102 will be eliminated, but it is still listed as an option for the required EES courses (I guess this will be fixed once the course is eliminated). I'll also note that elimination of EES102 will likely lead to significant changes in enrollment for other
introductory science and mathematics courses as students seek other means to obtain AXLE MNS credit."

EES Response to comment #1:

There are four key changes to requirements for major:

1) Dropping of the Environmental Geoscience major because of changes in faculty interests as well as to provide a clearer treatment of the relationships within and between disciplines of earth sciences and their importance.

2) Revision of courses currently required for the major to incorporate broad components of the earth sciences and their interactions. With one exception (202; see below), the numbers are not altered (EES 101/111, 220W, 225,226, 230, 240, 299, plus one additional >200 level course). However, modifying these courses and requiring 299 as described in the sections outlined in yellow will change the students’ experience and academic atmosphere. Even though we propose few changes in course numbers, there will be programmatic change as a result of changes within the courses. The rationale for including an explanation of changes that will be embedded within courses throughout the curriculum is that we thought that the purview and interests of the CEP and Council includes the educational atmosphere, goals, and approaches of the program, extending beyond what courses were added or subtracted. (Rationale is highlighted in yellow on memo to Professor Wollaeger.)

3) Addition of EES 202 and removal of EES 102 (with wording for 102 to count for 202 as new major requirements are instituted). This course reflects the integrative perspective that is key to our curriculum revision and will serve better to bridge the gap in expectations between introductory and majors level courses. (Rationale is highlighted in red on memo to Professor Wollaeger.)

4) Change in number of courses in mathematical, biological, and physical sciences required for the major. Previously, the most basic major had no requirements for courses in math and related sciences. In recognition of the fact that the Earth and Environmental Sciences are inherently interdisciplinary, the EES faculty determined that different levels of preparation in other sciences are necessary for students with different career objectives. These differing requirements in supporting science and mathematics courses constitute the fundamental distinction between Option I and Option II; Option III is the same as Option II with a required research component. (Rationale is highlighted in gray on memo to Professor Wollaeger. Note that in that memo, Options I, II, and III are referred incorrectly to as “Programs I, II, III”; in all other documents they correctly are termed “Options”. )

EES Responses to comment #2:

1) Apparently the description of Options I, II, and III was not included with materials sent to the Council. The omitted paragraph describing the Programs of studies is as follows and is inserted in the correct location preceding the list of required courses on the attached catalog revisions.
Three options are available within the EES major. All provide a solid grounding in the Earth and environmental sciences. The differences are in requirements for supporting sciences and mathematics and for research. Option I provides a background for careers or post-graduate work in related fields such as teaching, law, or business and for some graduate programs and employment opportunities in Earth and environmental sciences. Option II prepares students well for graduate work and careers in the Earth and environmental sciences. Option III (Honors) is designed for excellent, highly motivated students who want to pursue research as undergraduates.

2) EES 202 has been approved by the Curriculum Committee, but too late for Fall, 2010. It will be taught in Fall, 2011. Removal of EES 102 will have minimal impact on 100-level courses taught by other science departments. It consistently has had enrollment of fewer than 25 students. EES has recently added two new 100 level courses, EES 107, Volcanoes, and EES 114W, Ecology, Evolution and Climates through Time, both of which are popular with students seeking to fulfill AXLE MNS requirements.

Attached to this memo are new versions of text for the catalog. One shows the old text struck out, with the new text in red. The other provides the new text with the old text removed.

I encourage you to contact me if there are additional questions.

Cc: Mark Wollaeger, Chair, Committee on Educational Programs
Jonathan Bremer
Michael Muise

Attachments:
Memo to Mark Wollaeger  CEP Feb. 19
EES catalog changes red April 2010
EES catalog April 2010 version
Feb. 19, 2010

To: Mark Wollaeger, Chair, Committee on Educational Programs

From: Molly Miller, Director of Undergraduate Studies, Earth and Environmental Sciences (EES)

Subject: Revision of requirements for major and minor in EES

Attached are a “marked up” version of the EES section of the Undergraduate Catalog and a pristine version of the proposed new requirements for the major and minor. Minors in Environmental Science and Environmental Studies remain unchanged.

I. Changes in Earth and Environmental Sciences required courses

There are two reasons for the proposed changes. First, two courses required for the Environmental Geoscience Program are no longer offered; Professor Kaye Savage, who taught these courses, left Vanderbilt and she has not been replaced.

Second, as discussed below, the proposed changes reflect modifications in faculty understanding of the relationships within and between disciplines of earth sciences and their importance.

For several years the EES faculty has been pondering updating the majors’ curriculum to emphasize the interactions between broad components of the earth (e.g., lithosphere, hydrosphere, biosphere, and atmosphere) and earth processes and to de-emphasize description of the products of these processes independent of the broader context. We have converged on a common view of the study of geosciences as consisting of four overlapping spheres, including:

1. the study of earth materials and the processes by which they are transported and changed;
2. the study of processes operating at the surface of the earth and their effects and records;
3. the study of processes acting within the solid earth and their impacts on other parts of the earth;
4. the study of life on earth, including its history and interactions with the nonliving earth.

The curriculum as envisioned consists of two courses (EES 225 and EES 226) focused on earth materials (#1 above), one course (EES 230) concentrated on surface processes (#2), one course (EES 240) on solid earth processes (#3), and one course (EES 220W) on the biosphere and its development through time (#4). In addition, students would be required to take an introductory course with lab (EES 101/111) in which they
would learn about fundamental earth components, processes, and cycles, and about
gleologic time. In spring of senior year, students would participate in a largely student-
directed senior seminar designed to guide them into life-long self-directed learning about
the earth (EES 299).

With the exception of the senior seminar, none of the courses listed above are new
in general content; in fact the proposed curriculum includes only one entirely new
required course (EES 202, see below). What will be new is increased emphasis on
interconnectedness between the spheres. The following example illustrates the
significance of the change in emphasis. As one topic (among many covered) in the “old
EES 220” students learned how to identify different orders of corals, and what corals
built reefs at different times during geologic history. In the “new EES 220W” students
learn what different organisms built reefs at different times in the geologic past, but they
also connect differences between the orders of corals to their functioning as colonies and
to larger scale earth processes. The relatively small Ordovician reefs built 400 million
years ago by corals on the continental shelf in present-day Nashville were composed of
the mineral calcite (calcium carbonate) rather than of aragonite (also calcium carbonate)
as are modern fast growing, large reef-building corals. Diverse lines of evidence have
shown that during periods, including the Ordovician, of rapid production of ocean crust at
fast-spreading mid-ocean ridges (MOR), chemical interaction between new basaltic crust
created at the MOR and seawater changes the chemistry of ocean water worldwide to
favor precipitation of calcite over aragonite and calcite-secreting animals thrive. When
rate of plate motion slows, less new ocean crust is formed, ocean chemistry changes to
favor aragonite precipitation, and calcite secreting animals become extinct whereas
aragonite-secreting organisms proliferate. This particular topic in the new and old EES
220 course content remains the same (“corals and reefs”), but the context and
implications are very different. Changes like this have recently been made throughout the
courses listed above, and will continue to be made.

One new course, EES 202 (*Earth Systems through Time*), will be taken by all
students, ideally near the beginning of their major coursework following EES 101. By
focusing on the interconnections of earth components, processes, and cycles at several
intervals of earth history and how they are manifested in the rock record, the course will
provide context for all other EES courses. In addition, in lab students will master skills
and approaches that are needed for learning about the earth and its history. A description
of and a tentative syllabus for EES 202 are attached and will be submitted immediately to
the Curriculum Committee.

EES 202 is designed to fill a gap in the EES curriculum between the introductory
course (EES 101/111 *Dynamic Earth*) and the subdiscipline courses listed above (e.g.,
on earth materials, earth surface processes, life, solid earth). EES 101 is unusual, if not
unique, among introductory science courses because it (1) introduces students -- 90% of
whom are nonscientists and essentially none of whom had an earth science course in high
school -- to Earth and environmental sciences; (2) attracts majors; and (3) simultaneously
provides the intellectual basis for all other EES courses. Students with little interest in
science expect the course to be a painless avenue to checking-off the AXLE science
requirement, whereas EES faculty members expect EES 101 to prepare students for challenging upper level courses in the major. EES 202 will bridge the gap between the introductory and “sphere-content courses” of the major. Equally importantly it will demonstrate that the Earth functions as a single complex system, involving all the processes and materials that are the subjects of the other major courses and will introduce students to the use and interpretation of evidence about how the earth works.

Currently some of the content of EES 202 is covered in EES 102. However, because half or more of the students that enroll in EES 102 have had no previous earth science courses, it is not challenging for majors who have completed EES 101 and possibly other EES major courses. It will be eliminated after the EES 202 is established.

II. Supporting science and mathematics courses

Previously, the basic geoscience major required no courses in math or other sciences. The reality is that courses in math, chemistry, and physics are required for either graduate school in earth and environmental sciences or for a career in the field. Students were counseled that related sciences were required for graduate school, but there were no requirements.

In acknowledgment of the importance of the allied and mathematical sciences in the profession, the EES faculty determined that some courses in the natural sciences and math are necessary components of an EES major, including Program I. Balanced against this understanding is the fact that many EES majors were drawn to take a course in the geosciences simply by their antipathy for other sciences with which they were more familiar. Many intend to work in environmental law or environmental policy, and they do not see how courses basic sciences will help them in their chosen careers.

The requirements for Program II provide excellent preparation in supporting sciences and mathematics for students headed for a career or graduate studies in Earth and environmental sciences. The research component of Program III in concert with the EES courses and supporting sciences insure that students who complete Program III are excellent prepared for graduate studies or an entry level position in the field.

III. Impact on EES course offerings and teaching responsibilities

EES has 7 tenure-track faculty members, three of whom are assistant professors, one non-tenure track associate professor, one senior lecturer, and one lecturer. Each semester ~300 undergraduate students enroll in EES courses. The department also has built a nationally recognized and lauded MS program and is the driver of a thriving joint PhD program with Environmental Engineering. Given the ambitious programs at all levels, including the initiation of the new majors curriculum, teaching responsibilities for EES faculty will need to equilibrated and balanced to allow continued success in research and teaching.

Cc: Michael Muise