

Status: PENDING

PROGRAM REQUEST
Earth Sciences Ph.D.

Last Updated: Myers, Dena Elizabeth
07/26/2011

Fiscal Unit/Academic Org	School of Earth Sciences - D0656
Administering College/Academic Group	Mathematical And Physical Sci
Co-administering College/Academic Group	
Semester Conversion Designation	Re-envisioned with significant changes to program goals and/or curricular requirements (e.g., degree/major name changes, changes in program goals, changes in core requirements, structural changes to tracks/options/courses)
Current Program/Plan Name	Geological Sciences
Proposed Program/Plan Name	Earth Sciences Ph.D.
Program/Plan Code Abbreviation	GEOLSCI-PH
Current Degree Title	Doctor of Philosophy

Credit Hour Explanation

Program credit hour requirements		A) Number of credit hours in current program (Quarter credit hours)	B) Calculated result for 2/3rds of current (Semester credit hours)	C) Number of credit hours required for proposed program (Semester credit hours)	D) Change in credit hours
Total minimum credit hours required for completion of program		135	90.0	80	10.0
Required credit hours offered by the unit	Minimum				
	Maximum	135	90.0	80	10.0
Required credit hours offered outside of the unit	Minimum	0	0.0	0	0.0
	Maximum	0	0.0	0	0.0
Required prerequisite credit hours not included above	Minimum	0	0.0	0	0.0
	Maximum	0	0.0	0	0.0

Explain any change in credit hours if the difference is more than 4 semester credit hours between the values listed in columns B and C for any row in the above table

Total credit hours required are reduced to match minimum requirement of Graduate School; also reduced to minimize obstacle to student-progress-toward-degree arising from 3 credit limit on enrollment after passing Ph.D. Candidacy Exam.

Program Learning Goals

Note: these are required for all undergraduate degree programs and majors now, and will be required for all graduate and professional degree programs in 2012. Nonetheless, all programs are encouraged to complete these now.

Program Learning Goals •

Assessment

Assessment plan includes student learning goals, how those goals are evaluated, and how the information collected is used to improve student learning. An assessment plan is required for undergraduate majors and degrees. Graduate and professional degree programs are encouraged to complete this now, but will not be required to do so until 2012.

Is this a degree program (undergraduate, graduate, or professional) or major proposal? Yes

Does the degree program or major have an assessment plan on file with the university Office of Academic Affairs? No

Program Specializations/Sub-Plans

If you do not specify a program specialization/sub-plan it will be assumed you are submitting this program for all program specializations/sub-plans.

Pre-Major

Does this Program have a Pre-Major? No

Attachments

- Earth_Sciences_Ph.D._attachment_2_revised 24 July.doc: Earth Sci Ph.D. program proposal
(Program Proposal. Owner: Krissek, Lawrence Alan)
- Earth Sciences PhD cover letter.doc: NMS Division of Arts and Sciences cover letter
(Letter from the College to OAA. Owner: Andreck, Claude David)

Comments

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Krissek, Lawrence Alan	06/19/2011 11:02 AM	Submitted for Approval
Approved	Krissek, Lawrence Alan	06/19/2011 11:05 AM	Unit Approval
Revision Requested	Andreck, Claude David	07/22/2011 03:25 PM	College Approval
Submitted	Krissek, Lawrence Alan	07/24/2011 05:15 PM	Submitted for Approval
Approved	Krissek, Lawrence Alan	07/25/2011 08:56 AM	Unit Approval
Approved	Andreck, Claude David	07/25/2011 01:46 PM	College Approval
Approved	Myers, Dena Elizabeth	07/26/2011 03:08 PM	GradSchool Approval
Pending Approval	Cameron, Erin Marie Soave, Melissa A	07/26/2011 03:08 PM	CAA Approval



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July 25, 2011

Dena Myers
Graduate School
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230 North Oval Mall
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Dear Dena:

It is a pleasure to forward to you for your consideration the proposal for the doctoral program in Earth Sciences. The School of Earth Sciences is requesting that the name of the program be changed from Geological Sciences to Earth Sciences to better align with the name of the school and the nature of the program itself. The program has been revised from its quarter version mainly through a reduction in credit hours, to better align with the goal of completing the candidacy exam in a timely fashion and the three credit hour post-candidacy policy.

Beyond my own review of the documents, the proposal has been discussed by colleagues from other NMS units at meetings on July 22, 2011. Feedback from these discussions has been incorporated in the proposal.

If you have any questions, I would be happy to address them.

Sincerely,

David Andereck
Professor of Physics
Associate Dean of Natural and Mathematical Sciences, College of Arts and Sciences

LETTER FROM PROGRAM-OFFERING UNIT

DATE: 9 June 2011

TO: NMS, Graduate School, and OAA Reviewers

FROM: Lawrence Krissek, Associate Director for Administration, School of Earth Sciences
and
W. Berry Lyons, Director, School of Earth Sciences

SUBJECT: Conversion of graduate programs (M.S. and Ph.D.) in the School of Earth Sciences from quarters to semesters

At the graduate level, the School of Earth Sciences presently offers an M.S. in Geological Sciences (with both a thesis option and a non-thesis option), and a Ph.D. in Geological Sciences. During the conversion to semesters, we request that the names of these programs be changed from Geological Sciences to Earth Sciences, so that the names of these degree programs match the name of our School. This detail was not included at the time the School of Earth Sciences was established, so the quarter-to-semester conversion provides an opportunity to establish uniformity between the name of our unit and the names of our graduate programs.

The School of Earth Sciences also offers an M.S. in Geodetic Sciences (with both a thesis option and a non-thesis option) and a Ph.D. in Geodetic Sciences; both the M.S. and the Ph.D. programs will be converted to the semester format. These programs will retain their present names, because of the long history and distinct identity of Geodetic Sciences at Ohio State.

Graduate Programs in Earth Sciences (presently Geological Sciences)

In addition to changing the names of our existing graduate programs in Geological Sciences, the extent of change during the quarter-to-semester conversion ranges from minimal (for the conversion of the M.S. in Geological Sciences to the M.S. in Earth Sciences) to slightly more significant (for the conversion of the Ph.D. in Geological Sciences to the Ph.D. in Earth Sciences, which includes a reduction in credit hour requirements beyond the standard 2/3rds ratio).

The process that developed the conversions proposed here was led by Prof. William Ausich, Associate Director for Graduate Studies in SES. The requirements of the existing graduate programs in Geological Sciences were discussed within the SES Graduate Studies Committee, with input from both faculty and graduate student members. Each member of the Graduate Studies Committee consulted with his/her constituency within SES (i.e., the Earth History Division, the Earth and Planetary Dynamics Division, the Water, Environment, and Climate Division, and the graduate students), so that all faculty and graduate students had the opportunity to provide input to the proposed conversions. In addition, Prof. Ausich held an open forum with all interested graduate students in Autumn 2010, and the plans for program conversion were discussed, as they developed, at several faculty meetings in Autumn 2010.

For the M.S. thesis option, consensus quickly developed that: 1) the quarter credit hour requirements should be reduced by the standard 2/3rds ratio, thereby keeping the semester requirements consistent with the minimum requirements established by the Graduate School; and 2) no new requirements should be added. The motion to convert the M.S. thesis option in this way was approved at a faculty meeting on 17 November 2010, with a vote of 21 in favor, 0 opposed, and 0 abstentions.

For the M.S. non-thesis option, consensus quickly developed to: 1) reduce the quarter credit hour requirements by the standard 2/3rds ratio; and 2) clearly define the courses that satisfy the core requirements and the capstone project. The Earth History Division, the Earth and Planetary Dynamics Division, and the Water, Environment, and Climate Division each identified a set of courses that will serve as core courses for their non-thesis M.S. students, and a new course (Earth Sci 8570) was created to satisfy the capstone requirement. The motion to convert the M.S. non-thesis option in this way was approved at a faculty meeting on 5 May 2011, with a vote of 16 in favor, 0 opposed, and 1 abstention.

For the Ph.D. program in Earth Sciences, discussion primarily focused on the number of graded credit hours to require under semesters. The Geological Sciences Ph.D. requirements for both graded quarter credit hours and total quarter credit hours were not changed several years ago, when the Graduate School reduced its minimum credit hour requirements; as a result, the standard 2/3rds reduction moving to semesters would have kept our requirements well above the minimum set by the Graduate School. Our Ph.D. students are – and will continue to be -- encouraged to take their candidacy exam during their 2nd year, in order to maintain “normal progress” toward their degree. However, an increasing number of them have encountered difficulty meeting our existing requirements for graded and total credit hours because of the combination of: 1) our continued requirement above the minimum established by the Graduate School; 2) the relatively early time when the Ph.D. candidacy exam is taken; and 3) the 3 credit limit for post-candidacy enrollment recently established by the Graduate School. This difficulty has been even more severe for our increasing number of students who enter the Ph.D. program without completing an M.S. first, because these students do not transfer credits – either graded or ungraded -- from their M.S. program.

Because we anticipate that Ph.D. students will continue to face this situation under semesters, it was proposed that the total credit hour requirement be reduced to 80 semester credit hours, in order to match the minimum requirements set by the Graduate School. This motion was approved by unanimous faculty vote on 17 November 2010. The remaining vote considered whether to set the minimum graded credit hour requirement at 30 semester credit hours or at 34 semester credit hours; at the faculty meeting of 17 November 2010, the vote was 12 in favor of 30 semester credit hours, 8 in favor of 34 semester credit hours, and 1 abstention. As a result, the semester version of our Ph.D. program requires a minimum of 30 graded semester credit hours, and a minimum of 80 semester credit hours.

Graduate Programs in Geodetic Sciences

The graduate programs in Geodetic Sciences are being significantly re-envisioned during conversion, both in terms of their credit hour requirements and in terms of the structure and course offerings within each program. This re-envisioning brings the credit hour requirements for the various Geodetic Science graduate programs into alignment with existing Graduate School guidelines. In addition, this re-envisioning is necessary because the move of the Geodetic Science program from Engineering to SES has significantly reduced the number of faculty and courses available to support these programs. As a result, the re-envisioned programs have been simplified and focused on the strengths of the existing Geodetic Science faculty within SES.

Conversion of the graduate programs in Geodetic Sciences was led by Prof. Christopher Jekeli, head of the Geodetic Sciences Division within SES. Because the Geodetic Sciences Division is small, conversion plans were developed through discussions and direct consultations within that Division. The conversion plans developed by the Geodetic Sciences Division were then distributed via e-mail to all SES faculty, and were discussed at an SES faculty meeting in February 2011. The proposed conversions were approved by an e-vote, with 20 in favor, 1 opposed, and no abstentions.

For the M.S. thesis option, the minimum credit hour requirements are reduced by more than the standard factor of 2/3rds, from a minimum of 52-57 quarter credit hours (depending on the area of concentration and the specific courses chosen) to a minimum of 30 semester credit hours. In the semester format, “core courses” are selected in 4 categories from lists of options, whereas “core courses” were more completely prescribed in the quarter format. Three pre-approved tracks of “core courses” are available under semesters, in the areas of Geodesy, GIS, and Geodynamics, whereas pre-approved tracks in Geodesy, Photogrammetry, and Mapping & GIS were available under quarters. This change in subject area of the tracks reflects the change in composition of the Geodetic Science faculty as they moved from Engineering to SES, and the reduction in the minimum credit hour requirement reflects the reduced faculty numbers in the Geodetic Science program. The M.S. thesis option maintains the requirement for independent research and the completion and defense of a written research thesis.

For the M.S. non-thesis option, credit hour requirements also are reduced by more than the standard factor of 2/3rds, from a range of 58-67 quarter credit hours (with the range depending on the specific courses chosen) to a minimum of 30 semester credit hours. As with the other Geodetic Science graduate programs, the reduction in the minimum credit hour requirement reflects the reduced number of faculty and course offerings in the Geodetic Science program. The M.S. non-thesis option maintains the requirements for a written technical paper and a written comprehensive examination.

For the Ph.D., credit hour requirements are reduced by more than the standard factor of 2/3rds, in order to align the minimum credit hour requirement (i.e., 80 semester credit hours) with the minimum now set by the Graduate School. A credit hour requirement higher than this value has become increasingly difficult for students to achieve, given the 3 credit-hour limit on enrollment after a student passes the Ph.D. candidacy exam. In addition, specific course requirements within the semester-version of the Ph.D. have been reduced significantly from those in the quarter-version because: 1) the decreased number of faculty supporting the Geodetic Science program cannot regularly offer all of the courses that were required under quarters; 2) the decreased number of faculty supporting the Geodetic Science program do not have the expertise to offer all of the courses included in the quarter-version of the program; and 3) the increase in elective hours will allow students to use appropriate courses offered by other Divisions within SES.

The details of these conversions are included in the appropriate program templates and proposals. Please contact us if you have any questions.

Thank you for your attention to these proposals.

W. Berry Lyons
Professor and Director
School of Earth Sciences

Lawrence Krissek
Professor and Associate Director for Administration
School of Earth Sciences

Earth Sciences (presently Geological Sciences) Ph.D. Program Rationale Statement

The overall goal of the Graduate Degree Program in the School of Earth Sciences is to provide students the opportunity to develop advanced professional training in the Earth Sciences. Specific objectives of the program include providing opportunities for students to participate in advanced classes and seminars and to conduct independent research on fundamental issues in the Earth Sciences. The products of Ph.D. research projects are expected to be suitable for publication in the refereed scientific literature.

The Ph.D. degree is a research degree, so most coursework is taken during the first 2 years. Usually only advanced seminars – or pertinent courses that are offered infrequently – are taken in the 3rd and subsequent years. The purpose of coursework in the Ph.D. program is threefold:

- 1) to prepare students to complete the Ph.D. candidacy exam (which should be taken by the end of the student's 2nd year in the program);
- 2) to prepare students to undertake significant original research in the Earth Sciences, culminating in the Ph.D. dissertation; and
- 3) to prepare students for a long and productive career in the diverse field of the Earth Sciences.

Students who enter the program with a well-defined research project can enroll in research credits as early as the first term of their matriculation, whereas most begin to enroll in research credits no later than the autumn term of their 2nd year.

The Ph.D. program in the School of Earth Sciences (presently titled the Ph.D. in Geological Sciences) traditionally has enrolled students who have completed a thesis-based M.S. degree, and we expect most future students to continue to have this background. These students import a significant number of credit hours from their M.S. However, an increasing number of our Ph.D. students are either:

- 1) applying for admission directly from the B.S. to the Ph.D. program; or
- 2) applying to transfer to the Ph.D. program before (and without) completing their M.S.

These students are expected to complete their Ph.D. candidacy exam on the same schedule as the students who previously have completed an M.S., but have accumulated fewer credit hours at the time of the Ph.D. candidacy exam. This fact – combined with our present high credit-hour requirements and the Graduate School's limit on credit hours/term after the candidacy exam – has presented a significant obstacle to some students as they attempt to meet our existing credit-hour requirements for the Ph.D. In order to reduce this obstacle, we are reducing our overall credit-hour requirements under semesters to the minimum set by the Graduate School (i.e., 80 semester credit hours, which is a reduction by more than the standard ratio of 2/3), and we are reducing our requirement for graded credit hours by more than the standard ratio of 2/3.

Most of our graduate-level semester-version courses are one-to-one conversions of existing quarter-version courses. Due to the research interests and curricular needs of recent hires in the School of Earth Sciences, however, several new graduate-level courses are being created during the transition, particularly in the areas of oceanography and remote sensing/hydrology. At the same time, course offerings within the areas of geophysics and mineralogy/crystallography have been reorganized and streamlined, due to staffing changes. In converting our courses from quarters to semesters, 5 quarter-credit courses that do not include a lab generally have converted to 3 semester credits; this conversion maintains approximately the same amount of lecture time across the conversion. Our 5 quarter-credit courses that do include a weekly lab (most of which meet for 4 x 48 minute lectures and one 1:48 lab each week) generally have converted to 4 semester credits, with an anticipated meeting schedule of 3 x 55 minute lectures and one lab (~1:40) each week. This conversion maintains approximately the same amount of lecture time across

the conversion, and maintains a distribution of lecture vs. lab time that is necessary for the material covered. Our 3 quarter-credit courses generally have converted to 2 semester credits.

Details of the Proposed Conversion

The date of the last significant revision of the Geological Sciences (now requested to be Earth Sciences) Ph.D. was in the 1990s.

The proposed changes to the Ph.D. in Earth Sciences can be categorized overall as a significant re-envisioning of requirements, involving:

- 1) a change the name of the degree program from Geological Sciences to Earth Sciences; and
- 2) a reduction in credit-hour requirements by more than the standard ratio of 2/3.

The name change is proposed so that the name of the Ph.D. degree matches the name of our unit; the name change also is appropriate given the fact that our faculty, research areas, course offerings, and student interests have broadened from the traditional Geological Sciences to the more-encompassing Earth Sciences. We are requesting this name change for all degrees (B.S., B.A., minors, and graduate degrees) presently named “Geological Sciences”.

As outlined above, both the total credit-hour requirement and the requirement for graded credit hours are being reduced by more than the standard ratio of 2/3. These reductions are intended to bring our credit-hour requirements into alignment with the minimum requirements set by the Graduate School, and to reduce the obstacles to normal student progress that result from the 3 credit-hour limit on post-candidacy enrollment.

Except for the change in credit hour requirements by a factor greater 2/3rds, the details of the requirements for the Ph.D. remain the same from quarters to semesters. As was the case for the quarter-version, there are no required courses, other than the requirement for credit hours at the 8000 (formerly 800) level; instead, each student’s program of study is developed individually, in consultation with his/her advisor and Dissertation Committee. The details of selecting a Ph.D. dissertation project, completing the Ph.D. candidacy exam, conducting Ph.D. research, and writing/defending the Ph.D. dissertation remain the same in the conversion from the quarter-version to the semester-version.

Ph.D. Program in Earth Sciences (presently Geological Sciences)

Semester Version

1) Expected Background

A student normally enters the Ph.D. program after completion of a Master's degree, although in exceptional cases a student may be admitted directly from a baccalaureate program. A Ph.D. aspirant with an incomplete Master's degree may be admitted conditionally, and then must complete the M.S. degree within two semesters to remain in the Ph.D. program.

2) Degree Requirements

A minimum of 80 graduate semester credit hours beyond the baccalaureate degree is required for the Ph.D. degree. Students may apply a maximum of 30 semester credit hours (20 hours of graded coursework plus 10 research hours) earned as part of a Master's degree toward the 80 semester hours, according to the rules of the Graduate School. The School of Earth Sciences requires that the 80 semester hours must include at least 30 semester hours of graded graduate coursework in the sciences or appropriate related fields. The 30 semester hours of graded coursework must include at least 6 semester hours of 8000-level seminars.

A Ph.D. aspirant must pass the Ph.D. Candidacy Examination to be admitted to candidacy for the Ph.D. degree, and must complete and defend a dissertation that presents the results of an independent, original research project that is a scholarly contribution to the science. All components of these requirements (i.e., the Ph.D. Candidacy Examination, the Ph.D. dissertation, and the Ph.D. oral defense) must be fulfilled to meet the requirements of the Graduate School. The student must prepare a Dissertation Proposal, which is reviewed and approved by his/her advisor, his/her Advisory Committee, and the Earth Sciences Graduate Studies Committee, before beginning the Ph.D. Candidacy Examination.

No specific courses are required to complete the Ph.D. in Earth Sciences. Instead, the student and his/her advisor and Ph.D. committee will identify a coherent set of courses appropriate to the student's field of specialization; because an advisor generally is identified for a Ph.D. student to be admitted, this advising about coursework and potential research topics will have begun by the time the student registers for his/her first semester. In general, all students within a particular Division in SES will complete a similar set of courses; however, required sets of "core courses" have not been established.

As an example, here is the possible coursework taken by a Ph.D. student in the Earth History Division during his/her first 2 years of study (i.e., prior to completing the Ph.D. Candidacy Examination):

Possible Plan of Coursework for Ph.D. Student in the Earth History Division, Prior to Completing the Ph.D. Candidacy Examination			
Autumn Semester, Year 1	Spring Semester, Year 1	Autumn Semester, Year 2	Spring Semester, Year 2
Earth Sci 5621 Intro to Geochemistry 3 credits	Earth Sci 5602.01 Carbonate Systems I 2 credits	Earth Sci 5604 Sequence Stratigraphy 3 credits	Earth Sci 8800 Seminar in Stratigraphy and Basin Analysis 2 credits
Earth Sci 5614 Paleobiology 4 credits	Earth Sci 5602.02 Carbonate Systems II 2 credits	Earth Sci 5615 Paleoecology 4 credits	Earth Sci 8999 Research for Dissertation 15 credits
Earth Sci 8810 Seminar in Paleobiology 2 credits	Earth Sci 5605 Paleoceanography 3 credits	Earth Sci 8801 Seminar in Sedimentology 2 credits	
Earth Sci 8998 Research 8 credits	Earth Sci 5613 Micropaleontology 4 credits	Earth Sci 8998 Research 8 credits	
	Earth Sci 8998 Research 6 credits		
Total = 17 credit hours (9 graded semester credit hours + 8 ungraded semester credit hours)	Total = 17 credit hours (11 graded semester credit hours + 6 ungraded semester credit hours)	Total = 17 credit hours (9 graded semester credit hours + 8 ungraded semester credit hours)	Total = 17 credit hours (2 graded semester credit hours + 15 ungraded semester credit hours)
Cumulative = 9 graded credits 8 ungraded credits	Cumulative = 20 graded credits 14 ungraded credits	Cumulative = 29 graded credits 22 ungraded credits	Cumulative = 31 graded credits (including 6 credits of 8000-level seminars) 37 ungraded credits

In this example – which assumes that this student has not completed an M.S. and, therefore, has not transferred any credits from that degree – the student has completed all requirements for graded coursework by the end of the 2nd academic year, which is also the time when the student is expected to complete the Ph.D. Candidacy Examination. At the end of the 2nd academic year, this student also has completed a total of 68 semester credit hours, so that a minimum of 12 additional semester credit hours is

required for this student to meet the minimum total credit hour requirement for the Ph.D. With the 3 credit-hour limit on enrollment after the Ph.D. Candidacy Examination, this means that the student will have to register for at least 4 additional semesters/terms, or slightly more than the post-candidacy residence requirements set by the Graduate School.

In this example, a student who enters the Ph.D. program without an M.S. is able to complete the credit-hour requirements for the Ph.D. within 4 academic years, which SES would consider “normal progress” toward the degree. For comparison, the 2/3rds conversion of our existing total credit-hour requirement (i.e., 135 total quarter credit hours, converting to 90 semester credit hours) would require the student to register for an additional 4 semesters/terms – or more than 1 additional calendar year -- in order to meet that larger credit hour requirement. This would extend the minimum time-to-degree to >5 academic years, which SES would not consider “normal progress”.

A student who enters the Ph.D. program with a thesis-option M.S. – and therefore is able to count 20 semester hours of graded coursework and 10 semester hours of ungraded coursework toward the Ph.D. requirements – will be able to complete the credit-hour requirements for the Ph.D. more quickly.

3) Program Approval Form

In consultation with the student’s advisor, and with approval of the GSC, each student shall design a course of study appropriate to the field of specialization. This will be entered on the *Program Approval Form* and submitted to the GSC. It will provide a record of the proposed coursework, and will serve as a guide for the completion of this portion of the Ph.D. program.

The course of study will also remedy program deficiencies in earth sciences, mathematics and the basic sciences, to bring the student to the level required to do work in the field of specialization. These deficiencies will be identified by review of the student’s previous coursework and research, and will be agreed-to by the student, his/her advisor, and the GSC Chair. The *Program Approval Form* will provide a record of the proposed coursework, and it will serve as a guide for the completion of this portion of the graduate program. A student should complete all deficient coursework with a grade of “B” or better within one year of entry into the program.

4) Advisory Committee Selection

It is assumed that a Ph.D. student, before entering the program, has met with a potential advisor and discussed possible research topics. By the end of the second semester, the advisor and the student will choose two additional faculty members to serve on the Ph.D. Advisory Committee. The GSC, in consultation with the advisor, will choose a fourth member of the faculty to serve on the committee. The fourth member shall be from outside the student’s area of principal interest. In some instances the student and the advisor may wish to add a further faculty member to the committee, but this person shall not replace the member chosen by the GSC.

5) Advisory Committee Meetings

The student shall meet with the Advisory Committee at the beginning of the student’s program (prior to submission of the student’s proposal), and a minimum of once per year after the Dissertation proposal has been approved. The purpose of these meetings shall be to review both the academic and research

progress of the student. A letter report of the Advisory Committee meetings shall be prepared by the advisor, sent to the GSC Chair, and placed in the student's file.

6) Transfer to the PhD program before completion of the MS degree

Students who initially enroll as MS students in the School of Earth Sciences may petition the GSC committee to transfer to the PhD program without completion of the MS degree. This process is reserved for students who make an exceptional start in their graduate research and can establish their ability to do PhD-level research early in their time as a graduate student. A petition to the GSC must occur within 18 months of starting the MS program. The petition must include a letter from the student requesting the conversion, describing their research, their accomplishments (papers, meeting abstracts, awards), and a list of faculty who can comment on their abilities. The petition must be accompanied by a letter of support written by the student's research advisor outlining the evidence for PhD-level abilities.

Students granted a conversion between the MS and PhD program will be expected to submit a dissertation proposal and take their Ph.D. Candidacy Exam on the same schedule as other PhD students based on their initial matriculation date, not on the date of their transition from the MS program to the PhD program.

In the event that a student who went through the conversion fails the Ph.D. candidacy exam, that student may reapply to the Graduate School for readmission to the MS program. In that case, an MS thesis will remain a requirement for the MS degree.

A student in the Ph.D. program without an M.S. who passes the Ph.D. candidacy exam, but not does complete the dissertation in a timely manner, can receive the M.S. by applying for M.S. graduation according to the rules of the Graduate School.

7) Admissions to Candidacy and Candidacy Examination

A Ph.D. aspirant must pass a Candidacy Examination to be admitted to candidacy for the Doctoral degree. The Ph.D. Candidacy Examination should be completed within the second year of enrollment in the Ph.D. Program, includes both written and oral parts, and follows all Graduate School guidelines. A part-time student should complete the Candidacy Examination either during the semester following the semester in which the student has earned 20 graduate credit hours, or according to the approved program. During the semester of the Candidacy Exam, the student must be in good standing and must meet registration requirements set by the Graduate School.

The Candidacy Examination is administered by the student's Advisory Committee (which, in most cases, also serves as the student's Dissertation Committee). The Advisory Committee will be assembled as described in Section 4, by the end of the student's second semester of enrollment, and reviews and approves the student's Dissertation Proposal prior to the beginning of the Candidacy Examination. The examination consists of both written and oral portions. The Candidacy Examination shall test the student in the chosen field of dissertation research, as well as in related fields.

The format, principles and policies for the Candidacy Examination adhere to those of the Graduate School. If the Candidacy examination must be repeated, it should be retaken during the second semester following the first examination.

The student becomes a Ph.D. candidate on successful completion of the Candidacy Examination. NOTE: If the final oral exam is not taken within five years of admission to Candidacy, the Candidacy exam must be retaken, as required by the Graduate School.

8) Dissertation

To be awarded the Ph.D. degree, a student must complete a dissertation that presents the results of an independent, original research project that is a scholarly contribution to the sciences. The dissertation document must be prepared according to the guidelines described in the Graduate School Handbook.

9) Final Oral Examination

A Ph.D. candidate must satisfactorily defend the dissertation research in a Final Oral Examination, and must submit an approved copy of the dissertation to the Graduate School. These requirements must be fulfilled according to the requirements of the Graduate School.

10) Ph.D. Research Requirements

a) Choice of Research Area

A Ph.D. student is expected to have identified an area of proposed research and contacted potential faculty advisors at the time of application to the program or by the time of initial registration. A student has until the end of the first semester of registration to select an area of research, by which time he/she also should have obtained the consent of a faculty member to serve as his/her Ph.D. advisor.

b) Dissertation Committee Selection

The student's Advisory Committee should be established by the advisor and the student before the end of the second semester of registration. The committee must include at least four members of the graduate faculty, among them the advisor and two faculty members with appropriate expertise. A fourth member, from outside the student's area of specialization, shall be appointed by the GSC after consultation with the student's advisor. Unless a substitution is approved by the GSC, the Advisory Committee also serves as the student's Dissertation Committee.

c) Dissertation Research Proposal

Before the end of the second year of enrollment (two calendar years), a Ph.D. aspirant should prepare a written dissertation proposal that outlines the student's research problem. The proposal shall include: (1) title page, (2) nature and significance of the research, (3) description of the procedures to be employed, (4) projected timetable for completion of the project, and (5) estimated budget (stipend and its duration, anticipated source of funds; fieldwork costs; analytical costs and technician time; computer hardware and software costs; illustration expenses; etc.). NOTE: Anticipated and/or potential sources of funds for the research also must be identified for all budget categories. A separate flyer on thesis and dissertation proposals is available to all students.

The student's advisor and the other members of the Advisory Committee will review the dissertation proposal, and the proposal with appropriate revisions will be submitted to the GSC with the advisor and Advisory Committee/PhD Dissertation Committee signatures indicating approval for submission. The

GSC in turn will review the proposal with respect to science plan, timetable, and budget, and if all is in order the proposal will be accepted and included in the permanent file of the student. The Dissertation proposal must be approved by the Advisory Committee and GSC before the Candidacy Examination. Significant changes to the proposed dissertation research must be approved by the Advisory Committee and GSC.

d) Application to Graduate

The candidate must submit an *Application to Graduate* form to the Graduate School, according to Graduate School rules, in the semester in which graduation is expected.

e) Dissertation

The candidate must submit a typed draft of the completed dissertation to the Dissertation Committee for review. Approval of the dissertation draft means that the members of the committee judge it to be of sufficient merit to warrant holding the Final Oral Examination. Each committee member indicates approval of the draft copy of the dissertation by signing the *Draft Approval/Notification of Final Oral Examination* form that must be submitted to the Graduate School according to Graduate School requirements.

f) Doctoral Dissertation Lecture

In the academic semester during which the Final Oral Examination is undertaken, the candidate is encouraged to present a research lecture to an audience comprising faculty, students and guests. The lecture, of approximately 40 minutes duration, will treat the principal dissertation results to be presented, discussed and defended at the Final Oral Examination. There will be an opportunity for the audience to discuss research results with the candidate at the conclusion of the presentation. The lecture shall be attended by the advisor and Dissertation Committee. Note that the candidate is required to present a brief (10-15 minute) summary of the principal dissertation results at the Final Oral Examination.

g) Final Oral Examination Committee

The committee for the Final Oral Examination will meet the requirements set by the Graduate School. It will include the members of the Dissertation Committee plus a Graduate Faculty representative appointed by the Graduate School.

h) Scheduling the Final Oral Examination

The *Application to Graduate* form must be submitted to the Graduate School by the deadline established by the Graduate School. The Final Oral Examination cannot be scheduled until the Dissertation Committee has approved the dissertation document.

The Final Oral Examination must be scheduled during regular class or final examination periods of the quarter and must take place during normal University business hours, according to Graduate School guidelines.

i) Guidelines for Reading Dissertation

At least one week must be allowed for reading of the dissertation by the members of the Dissertation Committee. The reading copy of the dissertation should be complete (i.e., with table of contents, illustrations, references, etc.).

j) Conduct of Final Oral Examination

The rules and regulations covering the PhD Final Oral Examination are detailed in the Graduate School Handbook. The GSC of SES adheres to these rules and regulations. The format, principles and policies of the Final Oral Examination in SES satisfy the Graduate School's requirements. The format, principles, and policies of the examination enable the Ph.D. aspirant to present research results and engage in discussion of these and other topics before an audience of mentors, teachers and the student's peer group, as well as responding to formal questioning by the Examination Committee.

The Attendance policy for the Final Oral Examination follows Graduate School guidelines, specifically that "*...all committee members are expected to participate in questioning during the course of the examination and in the discussion of and decision on the result. Other faculty members and graduate students may attend the examination, subject to the rules of the GSC*"

As required by the Graduate School, the presentation of research at the Final Oral Examination in SES is open to all faculty and students, but only the Examination Committee is present for the formal examination, discussion of the student's performance and the decision about the outcome of the examination. Each examiner indicates judgment by signing the *Final Oral Examination Report* form that must be submitted to the Graduate School no later than the Wednesday two weeks prior to commencement.

Approximately one week before the Final Oral Examination (the dissertation defense), the time and place will be broadly announced to all faculty and students of the School of Earth Sciences and other interested persons. A title and abstract of the dissertation will also be provided.

According to Graduate School rules, the advisor chairs the examination, and the duration of the final examination is approximately 2 hours.

Format for the PhD Final Oral Examination:

1. Introduction of Ph.D. degree candidate, the candidate's committee, the Graduate School Representative, and a welcome to all other faculty, students and guests. The introduction and welcome shall be conducted by the candidate's advisor.
2. A 10 to 15 minute *brief synopsis* of the dissertation research will be presented by the Ph.D. candidate.
3. Questions addressed to the candidate by School of Earth Sciences faculty (non-committee members), students, and guests. These questions shall take no more than 15 minutes. All but the candidate, the Dissertation Committee, and the Graduate School Representative are excused at the conclusion of this portion of the Final Oral Examination.
4. Questions addressed to the doctoral candidate by the Dissertation Committee and the Graduate School Representative. The candidate is excused at the completion of this portion of the exam.

5. Meeting of the candidate's committee, along with the Graduate School Representative, to consider action on the Graduate School Final Oral Examination and Dissertation forms. Decisions taken are then immediately announced to the candidate.

NOTE: In addition to the electronic submission of the dissertation required by the Graduate School, a hardbound copy of the dissertation must be presented to Orton Library.

11) Good Standing and Normal Progress

To remain in good standing, a student must maintain a GPA of 3.0 and maintain reasonable progress. Normal progress for a student in the School of Earth Sciences requires that the student:

1. has a Program Approval Form on file with the GSC
2. meets the course load requirements set by the Graduate School
3. has an annual Advisory Committee meeting that is reported to the GSC
4. has a dissertation proposal approved and filed by the end of the second year of enrollment
5. takes the Candidacy Examination within the prescribed time

After successful completion of the Candidacy Examination, the advisor and Dissertation/Advisory Committee will monitor progress on the dissertation research and report annually to the GSC.

12) Registration Guidelines

A Ph.D. student is generally expected to complete all requirements for his or her degree within five years of the semester following successful completion of the Candidacy Examination.

A student must register for at least one credit hour to maintain office space and to use School and University facilities.

A student must meet Graduate School guidelines for registration during the semester in which any portion of the General Examination is taken, the semester during which the Final Oral Examination is taken, and the semester of expected graduation.

13) Financial Support for Graduate Students

Qualified Ph.D. students, who are offered support when first accepted into the Ph.D. program, are conditionally assured support for eight academic-year semesters (not including summer support). Support is conditional on maintaining normal progress, on maintaining good standing in the Graduate School, and on satisfactory performance of GTA or GRA duties. Support is also conditional on availability of funds. Additional support beyond four years may be awarded to a student, subject to satisfactory progress toward completion of the Ph.D. degree and satisfactory performance as a GTA or GRA, as well as availability of funds.

Registration requirements for GTAs, GRAs, fellowships, etc. are those set by the Graduate School.

Ph.D. Program in Geological Sciences

Quarter Version

- 1) **Expected Background** – same as in semester version
- 2) **Degree Requirements** – minimum of 135 graduate quarter credits, including a minimum of 60 quarter credit hours of graded graduate coursework. The 60 quarter credit hours of graded coursework must include at least 12 quarter credit hours of 800-level seminars. Other requirements same as in semester version.
- 3) **Program Approval Form** – same as in semester version
- 4) **Advisory Committee Selection** – same as in semester version
- 5) **Advisory Committee Meetings** – same as in semester version
- 6) **Transfer to the PhD program before completion of the MS degree** – same as in semester version
- 7) **Admissions to Candidacy and Candidacy Examination** – same as in semester version
- 8) **Dissertation** – same as in semester version
- 9) **Final Oral Examination** -- same as in semester version
- 10) **Ph.D. Research Requirements**
 - a) **Choice of Research Area** – same as in semester version. Advisor identified by end of second quarter in program.
 - b) **Dissertation Committee Selection** – same as in semester version. Committee established by end of third quarter in program.
 - c) **Dissertation Research Proposal** – same as in semester version. Proposal due by end of second year of enrollment.
 - d) **Application to Graduate** – same as in semester version.
 - e) **Dissertation** – same as in semester version.
 - f) **Doctoral Dissertation Lecture** – same as in semester version.
 - g) **Final Oral Examination Committee** – same as in semester version.
 - h) **Scheduling the Final Oral Examination** – same as in semester version
 - i) **Guidelines for Reading Dissertation** – same as in semester version
 - j) **Conduct of Final Oral Examination** – same as in semester version

11) Good Standing and Normal Progress – same as in semester version

12) Registration Guidelines – same as in semester version

13) Financial Support for Graduate Students – same as in semester version. Students offered support on admission are conditionally assured support for 12 academic-year quarters (not including summer support).

Transition Plan

Students who began their degree under quarters will not be penalized as we move to semesters, either in terms of progress towards their degree or their expected date of graduation. Arrangements will be made for individual students on a case-by-case basis by their advisors and the Graduate Studies Committee within Earth Sciences, but we anticipate few complications because few of our courses are contained in sequences, and because most of our courses are converting on a 1-to-1 basis.

Because our Ph.D. degree requirements are specified in terms of a required number of credit hours, rather than a required number of courses, credit hours will serve as the “currency” during the transition. Students who have completed graded coursework under quarters will be allowed to count the semester credit hours for the equivalent semester courses toward their degree requirements. For example, if a student has completed a 5 quarter-credit course that is converted to a 4 semester-credit course, the student will count that course for 4 semester credits. If a student has completed a 5 quarter credit-hour course that is converted to a 3 semester-credit course, the student will count that course for 3 semester credits. Credits graded S/U – such as independent study and research -- will be converted using a factor of 2/3rds (i.e., 3 quarter credits will be counted as 2 semester credits).

EARTH SCIENCE SEMESTER COURSES AVAILABLE IN EARTH SCIENCES Ph.D.

	Semester Course Number	Semester Course Title	Semester Credits	Semester Prerequisites	Quarter Course Number & Credits
Earth Sciences	5189.01	Field Geology I	3	Earth Sci 4423, Earth Sci 6423, Earth Sci 423, or Geol Sci 423; Earth Sci 4530, Earth Sci 6530, Earth Sci 530, or Geol Sci 530; and written permission of instructor.	Graduate-eligible version of 581 (5)
Earth Sciences	5189.02	Field Geology II	3	Earth Sci 5189.01, Earth Sci 581 or Geol Sci 581	Graduate-eligible version of 582 (4)
Earth Sciences	5189.03, .04, .05, .06	Field Geology for Educators (various)	2	CANNOT BE USED TO MEET REQUIREMENTS FOR Ph.D. IN EARTH SCIENCES	583.01, .02, .03, .04 (3 each)
Earth Sciences	5191	Internship in the Earth Sciences	1-3	Junior standing or above; permission of instructor.	New course
Earth Sciences	5193.XX	Individual Studies (various topics)	1-5	Permission of instructor.	693.XX (1-5)
Earth Sciences	5194	Group Studies	1-5	Permission of instructor.	694 (1-5)
Earth Sciences	5203	Geo-environment and Human Health	3	GE or GEC data analysis course or equivalent; soph standing and above or permission of instructor.	New course
Earth Sciences	5206	Advanced Oceanography	3	Earth Sci 1100 or Earth Sci 100 or Geol Sci 100 or Earth Sci 1105 or Earth Sci 105 or Geol Sci 105 or Earth Sci 1121 or Earth Sci 121 or Geol Sci 121 or graduate student standing or permission of instructor.	New course

Earth Sciences	5550	Geomorphology	4	Earth Sci 1121 or Earth Sci 121 or Geol Sci 121; Earth Sci 1122 or Earth Sci 122 or Geol Sci 122; or permission of instructor.	Graduate-eligible version of 550 (5)
Earth Sciences	5580	Standards-Based Earth Science for Educators	1-4	CANNOT BE USED TO MEET REQUIREMENTS FOR Ph.D. IN EARTH SCIENCES	580 (1-5)
Earth Sciences	5584	Principles of Oceanography for Educators	2	CANNOT BE USED TO MEET REQUIREMENTS FOR Ph.D. IN EARTH SCIENCES.	584 (3)
Earth Sciences	5600	Siliciclastic Depositional Systems	4	Earth Sci 4502 or Earth Sci 6502 or Earth Sci 502 or Geol Sci 502 or equivalent.	600 (5)
Earth Sciences	5601.01	Sedimentary Petrology: Sandstones	4	Earth Sci 4502 or Earth Sci 6502 or Earth Sci 502 or Geol Sci 502 or equivalent, or permission of instructor.	601.01 (5)
Earth Sciences	5601.02	Sedimentary Petrology: Carbonate Rocks and Shales	4	Earth Sci 4502 or Earth Sci 6502 or Earth Sci 502 or Geol Sci 502 or equivalent, or permission of instructor.	601.02 (5)
Earth Sciences	5602.01	Carbonate Depositional Systems I	2	Earth Sci 4502 or Earth Sci 6502 or Earth Sci 502 or Geol Sci 502, or equiv.	602.01 (3)
Earth Sciences	5602.02	Carbonate Depositional Systems II	2	Earth Sci 5602.01 or Earth Sci 602.01 or Geol Sci 602.01 and permission of instructor.	602.02 (2)
Earth Sciences	5603	Stratigraphy	4	Earth Sci 4502, Earth Sci 6502, Earth Sci 502 or Geol Sci 502, or equivalent.	603 (5)

Earth Sciences	5604	Sequence Stratigraphy	3	Earth Sci 4502, Earth Sci 6502, Earth Sci 502 or Geol Sci 502, or equivalent.	604 (5)
Earth Sciences	5605	Paleoceanography	3	Sr or Grad standing in earth sci or related fields.	605 (5)
Earth Sciences	5613	Micropaleontology	4	Earth Sci 4501 or Earth Sci 501 or Geol Sci 501 or equivalent.	613 (5)
Earth Sciences	5614	Paleobiology	4	Earth Sci 4501 or Earth Sci 501 or Geol Sci 501 or equivalent.	614 (5)
Earth Sciences	5615	Paleoecology	4	Earth Sci 5614 or Earth Sci 614 or Geol Sci 614 or permission of instructor.	615 (5)
Earth Sciences	5617	Petrology of Earth and Planets	4	Earth Sci 4423 or Earth Sci 6423 or Earth Sci 423 or Geol Sci 423 or equiv.	617 (5)
Earth Sciences	5618	Advanced Historical Geology	2	Earth Sci 4502 or Earth Sci 6502 or Earth Sci 502 or Geol Sci 502 or equiv.	618 (3)
Earth Sciences	5621	Introduction to Geochemistry	3	Sr standing in earth sci or related fields; Chem 1220 or Chem 123 or equivalent or above, or permission of instructor.	621 (5)
Earth Sciences	5622	Stable Isotope Biogeochemistry	3	Sr standing in any science program or grad standing in any of the sciences or permission of instructor.	622 (5)
Earth Sciences	5625	Igneous Petrology	4	Earth Sci 4423 or Earth Sci 6423 or Earth Sci 423 or Geol Sci 423 or equivalent.	625 (5)
Earth Sciences	5627	Global Biogeochemical Cycles	3	Earth Sci 5621 or Earth Sci 621 or Geol Sci 621 or permission of instructor.	627 (5)
Earth Sciences	5628	Environmental Isotope Geochemistry	3	Earth Sci 5621 or Earth Sci 621 or Geol Sci 621 or permission of instructor.	628 (5)
Earth Sciences	5629	Principles of Petrology	3	Sr or Grad standing in earth science or related fields, or permission of instructor.	629 (5)

Earth Sciences	5636	Advanced Topics in Mineralogy and Crystallography	3	Earth Sci 4421 or Earth Sci 6421 or Earth Sci 421 or Geol Sci 421 or equivalent, or permission of instructor.	Replacement for 635 (4), 636 (4), 637 (3)
Earth Sciences	5641	Geostatistics	3	Stats 5301 or 528 or equivalent and Math 1251 or Math 153 or above, or permission of instructor.	641 (3)
Earth Sciences	5642	Geomathematical Analysis	3	Earth Sci 5641 or Earth Sci 641 or Geol Sci 641; and Math 1251 or Math 153 or above, or written permission of instructor.	642 (5)
Earth Sciences	5644	Tectonic Evolution of Continents	3	Earth Sci 4423 or Earth Sci 6423 or Earth Sci 423 or Geol Sci 423; and Earth Sci 4502 or Earth Sci 6502 or Earth Sci 502 or Geol Sci 502; and Earth Sci 4530 or Earth Sci 6530 or Earth Sci 530 or Geol Sci 530; or written permission of instructor.	644 (5)
Earth Sciences	5645	Advanced Structural Geology	4	Earth Sci 4530 or Earth Sci 6530 or Earth Sci 530 or Geol Sci 530 or equiv.	645 (5)
Earth Sciences	5646	Geodynamics	3	Earth Sci 4530 or Earth Sci 6530 or Earth Sci 530 or Geol Sci 530 or equiv.; Math 1252 or Math 153 or above; and Physics 1250 or Physics 131 or above; or permission of instructor.	646 (5)
Earth Sciences	5650	Glaciology	4	Earth Sci 4450 or permission of the instructor.	650 (5)
Earth Sciences	5651	Hydrogeology	4	Earth Sci 1121 or Earth Sci 121 or Geol Sci 121; and Math 1252 or Math 153 or above.	651 (5)
Earth Sciences	5655	Land Surface Hydrology	3	Math 1252 or Math 153 or above; and Chem 1210 or 121 or above; and Physics 1250 or Physics 131 or above.	New course
Earth Sciences	5660	Geology of Metallic Deposits	4	Earth Sci 4423 or Earth Sci 6423 or Earth Sci 423 or Geol Sci 423.	660 (5)

Earth Sciences	5661	Petroleum Geology	4	Earth Sci 4423 or Earth Sci 6423 or Earth Sci 423 or Geol Sci 423; and Earth Sci 4502 or Earth Sci 6502 or Earth Sci 502 or Geol Sci 502; or written permission of instructor.	661 (5)
Earth Sciences	5663	Global Change and Sustainability in the Earth System	4	Sr or grad standing in Earth Sci, or permission of instructor.	663 (5)
Earth Sciences	5670	General and Economic Geology of Selected Areas	2-4	Earth Sci 4502 or Earth Sci 6502 or Earth Sci 502 or Geol Sci 502; and Earth Sci 4530 or Earth Sci 6530 or Earth Sci 530 or Geol Sci 530; and Earth Sci 5550 or Earth Sci 550 or Geol Sci 550; or permission of instructor.	670 (3-5)
Earth Sciences	5675	Scanning Electron Microscopy	2	Chem 1210 or 1220 or equivalent or permission of instructor	675 (2)
Earth Sciences	5676	Elemental Chemical Analysis using Inductively Coupled Plasma Optical Emission and Mass Spectrometry	3	Junior standing or above; and Chem 1220 or Chem 123 or equivalent or above; and permission of instructor.	Replacement for 674 (1)
Earth Sciences	5680	Deep Earth Geophysics	3	Math 1252 or Math 153 or above; and Physics 1251 or Physics 133 or above.	680 (5)
Earth Sciences	5687	Energy Geophysics	3	Earth Sci 1121 or Earth Sci 121 or Geol Sci 121; and Math 1251 or Math 151 or above; and Physics 1250 or Physics 131 or above.	687 (5)

Earth Sciences	5703	Principles of Biostratigraphy	2	Earth Sci 4501 or Earth Sci 501 or Geol Sci 501 or Earth Sci 5613 or Earth Sci 613 or Geol Sci 613 or Earth Sci 5614 or Earth Sci 614 or Geol Sci 614; and Earth Sci 5603 or Earth Sci 603 or Geol Sci 603 or equiv; or written permission of instructor.	703 (3)
Earth Sciences	5713	Taxonomy and Phylogeny in the Fossil Record	2	Earth Sci 5614 or Earth Sci 614 or Geol Sci 614 or permission of instructor.	713 (3)
Earth Sciences	5714	Biometry	2	Earth Sci 5614 or Earth Sci 614 or Geol Sci 614; and Earth Sci 5641 or Earth Sci 641 or Geol Sci 641 or equiv; or permission of instructor.	714 (3)
Earth Sciences	5717	Critical Issues in World Freshwater Resources	4	Earth Sci 5651 or Earth Sci 651 or Geol Sci 651; Earth Sci 5752 or Earth Sci 752 or Geol Sci 752 recommended.	717 (5)
Earth Sciences	5718	Aquatic Geochemistry	3	Chem 122 or above; and Math 1251 or Math 152 or above; or equivs.	718 (5)
Earth Sciences	5719	Environmental Organic Geochemistry	3	Earth Sci 5718 or Earth Sci 718 or Geol Sci 718; and Chem 4200 or Chem 4300 or Chem 520; or permission of instructor.	719 (5)
Earth Sciences	5746	Seminar in Rheological Properties of Solids	1	Earth Sci 4530 or Earth Sci 6530 or Earth Sci 530 or Geol Sci 530; and Math 2253 or Math 254 or above; or permission of instructor.	746 (3)
Earth Sciences	5751	Quantitative Ground-Water Flow Modeling	4	Earth Sci 5651 or Earth Sci 651 or Geol Sci 651.	751 (5)
Earth Sciences	5752	Contaminants in Aqueous Systems	4	Earth Sci 5651 or Earth Sci 651 or Geol Sci 651.	752 (5)

Earth Sciences	5754	Risk Assessment and Management in Earth Systems	4	Earth Sci 5651 or Earth Sci 651 or Geol Sci 651 or equivalent course in engineering or environmental sciences, or permission of instructor.	754 (5)
Earth Sciences	5779	Seminar in Physical Properties of Minerals and Rocks	1	Earth Sci 4421 or Earth Sci 6421 or Earth Sci 421 or Geol Sci 421; Earth Sci 5680 or Earth Sci 680 or Geol Sci 680; or equivs; or written permission of instructor.	779 (3)
Earth Sciences	5780	Reflection Seismology	4	Earth Sci 1121 or Earth Sci 121 or Geol Sci 121; and Math 1251 or Math 151 or above; and Physics 1250 or Physics 131 or above.	780 (3)
Earth Sciences	5781	Gravity Exploration	3	Earth Sci 5687 or Earth Sci 687 or Geol Sci 687 or written permission of instructor.	781 (3)
Earth Sciences	5782	Magnetic Exploration	3	Earth Sci 5687 or Earth Sci 687 or Geol Sci 687 or written permission of instructor.	782 (3)
Earth Sciences	6421	Earth Materials	3	Chem 1210 or Chem 121 or equivalent.	Graduate-eligible version of 421 (5)
Earth Sciences	6423	Petrology	3	Earth Sci 1121 or Earth Sci 121 or Geol Sci 121; and Earth Sci 6421 or 4421 or 421 or Geol Sci 421.	Graduate-eligible version of 423 (5)
Earth Sciences	6502	Stratigraphy and Sedimentation	4	Earth Sci 1121 or 121 or Geol Sci 121; Earth Sci 1122 or 122 or Geol Sci 122.	Graduate-eligible version of 502 (5)
Earth Sciences	6530	Structural Geology	4	Earth Sci 1121 or Earth Sci 121 or Geol Sci 121; and Physics 131 or Physics 1250 or above.	Graduate eligible version of 530 (5)
Earth Sciences	6560	Applied Geophysics	3	Earth Sci 1121 or Earth Sci 121 or Geol Sci 121; Math 1251 or Math 151 or above; and Physics 1250 or Physics 131 or above.	Graduate-eligible version of 560 (5)

Earth Sciences	6750	Paleoclimatology	4	Graduate standing or permission of instructor.	750 (5)
Earth Sciences	7998	Research in the Earth Sciences	1-12	Permission of instructor.	999 (1-18)
Earth Sciences	7999	Research for Thesis in the Earth Sciences	1-12	Permission of instructor.	999 (1-18)
Earth Sciences	8570	Graduate Capstone Project in Earth Sciences	3	Permission of instructor. ONLY OPEN TO STUDENTS IN THE M.S. NON-THESIS OPTION.	New course.
Earth Sciences	8800	Seminar in Stratigraphy and Basin Analysis	1-2	Permission of instructor.	800 (1-3)
Earth Sciences	8801	Seminar in Sedimentology	1-2	Permission of instructor.	801 (1-3)
Earth Sciences	8810	Seminar in Paleobiology	1-2	Permission of instructor.	810 (1-3)
Earth Sciences	8821	Seminar in Geochemistry	1-2	Permission of instructor.	821 (1-3)
Earth Sciences	8822	Seminar in Mineralogy, Mineral Physics, and Petrology	1-2	Permission of instructor.	822 (1-3)
Earth Sciences	8840	Seminar in Structural Geology	1-2	Permission of instructor.	840 (1-3)
Earth Sciences	8850	Seminar in Glaciology and Geomorphology	1-2	Permission of instructor.	850 (1-3)
Earth Sciences	8851	Seminar in Hydrogeology and Oceanography	1-2	Permission of instructor.	851 (1-3)

Earth Sciences	8860	Seminar in Energy Resources	1-2	Permission of instructor.	860 (1-3)
Earth Sciences	8874	Seminar in History of Earth Science Concepts	1-2	Permission of instructor.	874 (1-3)
Earth Sciences	8878	Seminar in Geophysics	1-2	Permission of instructor.	880 (1-3)
Earth Sciences	8889	Interdepartmental Seminar in Polar and Alpine Studies	1-2	Permission of instructor.	896 (1-3)
Earth Sciences	8898	Colloquium in the Earth Sciences	1	Permission of instructor.	888 (1)
Earth Sciences	8998	Research in the Earth Sciences	1-12	Permission of instructor.	999 (1-18)
Earth Sciences	8999	Dissertation Research in the Earth Sciences	1-12	Permission of instructor.	999 (1-18)