Hydrol Sci Mgmt

DAVIS: ACADEMIC SENATE

July 1, 1992

PROFESSOR MARK E. GRISMER, Chair
Graduate Group in Hydrologic Science
Department of Land, Air and Water Resources

SUBJECT: **Hydrologic Science--Changes to Graduate Degree Requirements**

REF: Letter 12/13/91, Grismer to Curry
Group Program Announcement and Curricula

Dear Professor Grismer:

At its meeting on April 29, 1992, the Graduate Council reviewed your proposed changes to the degree requirements for the graduate program in Hydrologic Science. The Council also reviewed the existing degree requirements for the Water Science graduate program. After considering the overlap between the two programs, and the potential for merging the Water Science program into the Hydrologic Science program, the Council agreed to approve your requirement changes.

Sincerely,

Dianne S. Macleod

DIANNE S. MACLEOD, Chair
Graduate Council

DSM/MJD

# HYDROLOGIC SCIENCES GRADUATE GROUP

The graduate program in Hydrologic Sciences is a unique interdisciplinary program designed to broaden the skills and knowledge of the natural science or engineering student interested in the occurrence, distribution, circulation and properties of water on earth. Because of its ubiquity and importance to physical, chemical and biological processes, Hydrologic Science interfaces with the geologic, atmospheric and oceanic sciences, as well as, engineering and other applied physical sciences. Subject matter in the Hydrologic Sciences includes the material listed in the box below. Basic to the Hydrologic Sciences program is a core curriculum of courses shown on page 3. The program has three degree options at the M.S. and Ph.D. levels. These include Hydrology, Hydrobiology, and Hydrogeochemistry. Within each option, students may elect to specialize in particular defined areas under the direction of the Graduate Advisor or develop their own program from the suggested course list for the option. For example, a well-defined Subsurface Hydrology specialization is possible in the Hydrology option.

**Hydrologic Sciences**

A. Fluid Dynamics
   —geophysical fluid mechanics
   —dynamic meteorology
B. Hydrologic Phenomena
   —hydrology
   —geomorphology
   —boundary layer meteorology
C. Hydrogeochemistry
   —physical chemistry
   —aqueous geochemistry
   —chemistry of the hydrosphere
D. Hydrobiology
   —aquatic biology
   —plant-water relations
   —geomicrobiology
E. Hydrologic Techniques
   —numerical methods
   —geophysical techniques
   —remote sensing
   —site characterization
   —stochastic processes
F. Hydrologic Policy
   —resource economics
   —water law and institutions
   —water resources management

Students entering the program should have a strong undergraduate background in the sciences or engineering which includes calculus, physics with calculus, chemistry, and computer sciences. Depending on the degree option selected, additional coursework in differential equations, applied statistics, biology, chemistry and geology may be recommended or required. Students admitted to the program who are lacking some of the preparatory coursework can rectify these deficiencies during the first year of study under direction of the Graduate Advisor.

All students participating in the program are required to have coursework in fluid mechanics, hydrology, hydrogeochemistry and hydrologic policy prior to graduation. In addition, each student is required to complete HYS 200, an interdisciplinary seminar series considering various hydrologic phenomena from the perspective of scientists, engineers and water resource managers and HYS 290, a student seminar class. Shortly after commencing their studies, students should select a three-member faculty advisory committee, in consultation with the Graduate Advisor, to assist them in developing their program of study. Students electing to develop their own program of study within an option should prepare their program under consultation with their Faculty Advisor, the Graduate Advisor and Chair of the Group.

The following pages list the general requirements for students to complete the M.S. or Ph.D. degrees. These are followed by the preparatory and introductory course requirements for the different degree options. Finally, coursework applicable to each of the options and their specializations are listed.

## M.S. REQUIREMENTS (Plan I)

1. In consultation with the Graduate Advisor, the student will select a three-person advisory committee that includes the student's Faculty Advisor.

2. The student will work with the members of the advisory committee to develop a course of study that satisfies the introductory core curriculum and a minimum of 32 units of upper division and graduate level coursework. The course of study must include at least 14 graduate units exclusive of research (299) units. The course of study is then submitted before the end of the second quarter in residence to the Group Chair for approval.

3. The student will submit a thesis to be approved by a three-member thesis committee appointed by the Group Chair. The thesis will consist of a comprehensive report on the work that a student has performed on a specific research problem. An applied or professionally-oriented thesis topic is acceptable.

4. In addition to the written thesis, each student must present a public seminar on the campus of the contents and results of the research.

## M.S. REQUIREMENTS — Non-Thesis Option (Plan II)

The non-thesis option is designed for students planning to terminate their graduate studies at the M.S. level. Students planning to pursue the Ph.D. are advised to take the M.S. thesis option (Plan I).

1. In consultation with the Graduate advisor, the student will select a three-member advisory committee that includes the student's Faculty Advisor.

2. The student will work with the members of the committee to develop a course of study which satisfies the introductory core curriculum and a minimum of 38 units of upper division and graduate level coursework. The course of study must include at least 18 graduate units exclusive of research (299) units. The course of study is then submitted before the end of the second quarter in residence to the Group Chair for approval.

3. The student will prepare a project paper that demonstrates application of his specialization, to be approved by the student's Faculty Advisor, the Graduate Advisor, and Group Chair.

4. In addition to the project paper, the student must pass a comprehensive oral examination administered by a four-member faculty committee appointed by the Graduate Advisor.

## Ph.D. REQUIREMENTS

1. In consultation with the Graduate Advisor, the student will select a three-person advisory committee that includes the student's Faculty Advisor.

2. The student will work with the members of the committee to develop a course of study that is submitted before the end of the first year of residence to the Group Chair for approval.

3. Before the end of the seventh quarter of residence as a Ph.D. student, the student will submit a formal research proposal. The proposal should demonstrate the student's understanding of the significance and methodology of the proposed projects and his or her preparation to undertake the research. The proposal must be approved by each member of the student's advisory committee.

4. After approval of the research proposal but before the end of the eighth quarter in residence, the student must take the Qualifying Examination administered by a four-member committee appointed by the Graduate Advisor. The Examination will include a brief presentation of the planned dissertation research. The student may be questioned on his research proposal, research in progress in Hydrologic Science, and any relevant coursework.

5. The student will submit a dissertation for approval by a three-member thesis committee appointed by the Group Chair. The dissertation must represent an original contribution to fundamental knowledge in the Hydrologic Sciences. In addition to the written dissertation, each student must present a public seminar on the campus of the content and results of the research.

# HYDROLOGIC SCIENCES GRADUATE GROUP

## *PREPARATORY COURSEWORK*

*Mathematics/ statistics:*
Calculus (MAT 21A, B, & C)
Differential equations (MAT 22B)
Statistics (STA 130A & B or ECI 114)
Computer programming (ENG 5 or ASM 21)

*Physics/Chemistry:*
General physics (PHY 9A, B, & C)
General chemistry (CHE 2A, B, & C)

*Geology:*
Physical geology (GEL 50/50L),

*Students entering the Hydrobiology and the Hydrogeochemistry should have additional preparatory coursework in Biology (BIS 1A, B & C) and Organic Chemistry (CHE 8A & B). Physical Chemistry (CHE 107A & B for M.S. and CHE 110A, B & C for Ph.D. students) is strongly recommended for students in the Hydrogeochemistry option. Zoology (ZOO 112), Microbiology (MIC 102) and Biochemistry (BCP 101A) are strongly recommended for students in the Hydrobiology option.

## *REQUIRED INTRODUCTORY CORE COURSEWORK FOR ALL OPTIONS**

| Subject | Select one of the Courses listed for each subject | Units |
|---|---|---|
| Fluid Dynamics | ENG 103A, WSC 142, ECI 141, ATM 200 | 3 |
| Hydrology | WSC 141, WSC 149A, ECI 142, ECI 144 | 3 |
| Hydrogeochemistry** | SSC 102, WSC 180, GEL 115, HYS 1xx | |
| Hydrobiology** | WSC 104, WSC 122, SSC 111, EST 151 | 3 |
| Hydrologic Policy | WSC 150, AGE 147, GEO 162, EST 161 | 3 |
| Seminars | HYS 200 and HYS 290 (both required) | 3 |

*With the exception of HYS 200 and 290, similar coursework taken previously during undergraduate or graduate study may be substituted for equivalent courses in the above requirements.

**Students must select one course from either the Hydrogeochemistry or Hydrobiology subject matter area. Coursework in only one of these subjects is required.

## *INTRODUCTORY CORE COURSE TITLES*

| | | |
|---|---|---|
| **Fluid Dynamics** | ENG 103A | Elementary Fluid Mechanics |
| | WSC 142 | Hydraulics |
| | ECI 141 | Engineering Hydraulics |
| | ATM 200 | Atmospheric Processes |
| **Hydrology** | WSC 141 | Hydrology |
| | WSC 149A | Groundwater Hydrology |
| | ECI 142 | Engineering Hydrology |
| | ECI 144 | Groundwater Systems Design |
| **Hydrogeochemistry** | WSC 180 | Chemistry of the Hydrosphere |
| | SSC 102 | Soil and Water Chemistry |
| | GEL 115 | Geochemistry |
| | HYS 1xx | Aqueous Geochemistry |
| **Hydrobiology** | WSC 104 | Plant-Water-Soil Relationships |
| | WSC 122 | Biology of Running Waters |
| | SSC 111 | Geomicrobiology |
| | EST 151 | Limnology |
| **Hydrologic Policy** | WSC 150 | Water Law and Water Institutions |
| | AGE 147 | Natural Resource Economics |
| | GEO 162 | Geography of Water Resources |
| | EST 161 | Environmental Law |
| **Seminars** | HYS 200 | Seminar Survey of Hydrologic Sciences |
| | HYS 290 | Research Seminar (Student and Faculty Presentations) |

# *HYDROBIOLOGY OPTION*

This option considers the study of surface water and groundwater as related to their support of biological organisms, including the physical, chemical, and biological aspects of these waters. This option is appropriate for students desiring to study aquatic biology, surface water quality, biological remediation of water pollution, soil-plant-water relationships, wetlands restoration, and ecotoxicology.

List of Available Courses (not including core courses listed on page 3)

| | |
|---|---|
| WSC 100 | Principles of Hydrologic Science |
| WSC 103 | Water Quality, Salt Control and Reclamation |
| WSC 122L | Biology of Running Waters |
| WSC 201 | Advanced Plant-Water Relations |
| WSC 202 | Evapotranspiration |
| WSC 217 | Hydrochemical Models |
| WSC 222 | The Biology of Streams |
| BOT 117 | Plant Ecology |
| BOT 118 | Phycology |
| BOT 150 | Biology and Management of Freshwater Macrophytes |
| ECI 240 | Water Quality |
| ECL 203 | Physiological Ecology of Animals |
| ENT 116 | Biology of Aquatic Insects |
| EST 100 | General Ecology |
| EST 123 | Introduction to Field and Laboratory Methods in Ecology |
| EST 129 | Physiological Ecology |
| EST 129L | Physiological Ecology Laboratory |
| EST 150A | Physical and Chemical Oceanography |
| EST 150B | Geological Oceanography |
| EST 150C | Biological Oceanography |
| EST 151L | Limnology Laboratory |
| EST 165 | Science, Experts and Public Policy |
| ETX 101 | Principles of Environmental Toxicology |
| ETX 112A | Toxicants in the Environment |
| ETX 112B | Toxicants in the Environment |
| ETX 203 | Environmental Toxicants |
| ETX 220 | Analysis of Toxicants |
| ETX 220L | Analysis of Toxicants Laboratory |
| ETX 240 | Ecotoxicology |
| SSC 208 | Soil-Plant Interrelationships |
| SSC 211 | Advanced Soil Microbiology |
| WFB 120 | Biology of Fish |
| WFB 120L | Biology of Fish Laboratory |
| WFB 153 | Wildlife Ecotoxicology |
| ZOO 202 | Biomathematics |

# *HYDROLOGY OPTION*

This general option considers the study of the occurrence, distribution, processes affecting the movement of and management of water resources on the planet. Due to the breadth of subject material covered in this option, four specializations, or subsets of subject matter have been defined. These include Surface Hydrology, Subsurface Hydrology (Hydrogeology, Groundwater Hydrology), and two water management specializations, Water Resources Management and Irrigation and Drainage Systems. Courses for each of these four specializations are listed on the following pages.

## Surface Hydrology Specialization

This specialization of Hydrology considers the study of water and pollutant transport in the lower atmosphere, over the earth's surface and through near surface soils. Possible coursework covers the physics, chemistry and some biological aspects of surface waters and their interaction with subsurface waters.

List of Available Courses (not including core courses listed on page 3)

| | |
|---|---|
| WSC 100 | Principles of Hydrologic Science |
| WSC 103 | Water Quality, Salt Control and Reclamation |
| WSC 104 | Plant-Water-Soil Relationships |
| WSC 122 | Biology of Running Waters |
| WSC 149B & 149L | Groundwater Hydrology |
| WSC 200 | Hydrologic Modeling in the Vadose Zone |
| WSC 202 | Evapotranspiration |
| WSC 206 | Water Resources Systems Analysis (or ECI 273) |
| WSC 215 | Advanced Topics in Water and Soil Chemistry |
| WSC 217 | Hydrochemical Models |
| WSC 222 | The Biology of Streams |
| WSC 250 | Advanced Soil Physics |
| WSC 254 | Modeling of Hydrologic Processes (New course, Spring 1992) |
| WSC 255 | Analysis of Random Fields |
| ATM 120 | Atmospheric Thermodynamics and Statics |
| ATM 121A & 121B | Atmospheric Dynamics |
| ATM 133 | Biometeorology |
| ATM 158 | Boundary-Layer Meteorology |
| ATM 221A & 221B | Advanced Atmospheric Dynamics |
| ATM 223 | Advanced Boundary-Layer Meteorology |
| ECI 140 & 140L | Environmental Analysis of Aqueous Systems |
| ECI 142L | Engineering Hydrology Laboratory |
| ECI 145 | Hydraulic Structure Design |
| ECI 146 | Water Resources Simulation |
| ECI 212A | Finite Element Procedures in Applied Mechanics |
| ECI 212C | Finite Elements: Application to Fluid Problems |
| ECI 240 | Water Quality |
| ECI 244 | Environmental Quality Modeling |
| ECI 267 | Water Resources Management |
| ECI 273 | Water Resource Systems Engineering |
| ECI 275 | Hydrologic Time-Series Analysis |
| ECI 276 | Watershed Hydrology |
| EST 150A | Physical and Chemical Oceanography |
| EST 151 | Limnology |
| GEL 135 | Rivers of California: Geology and Land Use |
| GEL 153 | Geomorphology |
| GEL 154 | Environmental Geomorphology |
| GEO 106 | Aerial Photo Interpretation and Remote Sensing |
| HYS 230 | Introduction to Geostatistics |
| SSC 107 | Soil Physics |

# Subsurface Hydrology Specialization

This specialization of Hydrology considers the study of water and solute transport in soils and geologic media of the subsurface. This specialization is appropriate for students who want to study hydrogeology, groundwater hydrology, or vadose-zone hydrology. Those entering the program from non-geology programs are encouraged to take, at a minimum, GEL 105 & 105L and GEL 106.

List of Available Courses (not including core courses listed on page 3)

| | |
|---|---|
| WSC 100 | Principles of Hydrologic Science |
| WSC 103 | Water Quality, Salt Control and Reclamation |
| WSC 104 | Plant-Water-Soil Relationships |
| WSC 149B & 149L | Groundwater Hydrology |
| WSC 200 | Hydrologic Modeling in the Vadose Zone |
| WSC 215 | Advanced Topics in Water and Soil Chemistry |
| WSC 217 | Hydrochemical Models |
| WSC 250 | Advanced Soil Physics |
| WSC 255 | Analysis of Random Fields |
| ECI 140 & 140L | Environmental Analysis of Aqueous Systems |
| ECI 146 | Water Resources Simulation |
| ECI 171 & 171L | Soil Mechanics |
| ECI 174 | Environmental Geotechnology |
| ECI 176 | Geotechnical Modeling |
| ECI 212A | Finite Element Procedures in Applied Mechanics |
| ECI 212C | Finite Elements: Application to Fluid Problems |
| ECI 266A & 266B | Applied Stochastic Methods in Engineering |
| ECI 272A & 272B | Advanced Groundwater Hydrology |
| ECI 275 | Hydrologic Time-Series Analysis |
| ECI 276 | Watershed Hydrology |
| ECI 283 | Physicochemical Influences and In-Situ Evaluation of Soil Behavior |
| ETX 101 | Principles of Environmental Toxicology |
| GEL 105 & 105L | Structural Geology |
| GEL 106 | Ancient Environments |
| GEL 115 | Geochemistry |
| GEL 117B | Geophysics: Seismology and Heat Flow |
| GEL 124 | Sedimentary Petrology |
| GEL 134 | Environmental Geology and Land Use Planning |
| GEL 153 | Geomorphology |
| GEL 154 | Environmental Geomorphology |
| GEL 226 | Advanced Sedimentation and Sedimentary Petrology |
| GEL 250 | Advanced Geochemistry Seminar |
| HYS 220 | Numerical Modeling of Groundwater Systems |
| HYS 230 | Introduction to Geostatistics |
| HYS 240 | Multiphase Flow in Soils |
| SSC 107 | Soil Physics |
| SSC 111 | Geomicrobiology |
| SSC 207 | Transport Processes in Soils |
| SSC 211 | Advanced Soil Microbiology |

# Water Resources Management Specialization

This specialization of Hydrology considers the study of allocation and management of water resources as related to the economic, institutional, physical, chemical, and biological constraints on the circulation and quality of surface and subsurface waters. This specialization is at the interface between scientific hydrology and the legal/economic aspects of civilization.

List of Available Courses (not including core courses listed on page 3)

| | |
|---|---|
| WSC 100 | Principles of Hydrologic Science |
| WSC 103 | Water Quality, Salt Control and Reclamation |
| WSC 104 | Plant-Water-Soil Relationships |
| WSC 122 | Biology of Running Waters |
| WSC 149B & 149L | Groundwater Hydrology |
| WSC 154 | Water and Related Resource Allocation from Economic Principles |
| WSC 200 | Hydrologic Modeling in the Vadose Zone |
| WSC 202 | Evapotranspiration |
| WSC 206 | Water Resources Systems Analysis (or ECI 273) |
| WSC 222 | The Biology of Streams |
| WSC 254 | Modeling of Hydrologic Processes (New course, Spring 1992) |
| AGE 148 | Economic Planning for Regional and Resource Development |
| AGE 176 | Economic Analysis in Resource Use |
| ECI 140 & 140L | Environmental Analysis of Aqueous Systems |
| ECI 142L | Engineering Hydrology Laboratory |
| ECI 145 | Hydraulic Structure Design |
| ECI 146 | Water Resources Simulation |
| ECI 212A | Finite Element Procedures in Applied Mechanics |
| ECI 212C | Finite Elements: Application to Fluid Problems |
| ECI 240 | Water Quality |
| ECI 267 | Water Resources Management |
| ECI 268 | Public Works Management |
| ECI 269 | Water Supply and Hydro Power Planning |
| ECI 270 | Advanced Water Resources Management |
| ECI 271 | Water Resources Planning Laboratory |
| ECI 273 | Water Resource Systems Engineering |
| ECI 275 | Hydrologic Time-Series Analysis |
| ECI 276 | Watershed Hydrology |
| EST 150A | Physical and Chemical Oceanography |
| EST 151 | Limnology |
| EST 162 | Recreation Policy Analysis |
| EST 171 | Environmental Planning |
| GEL 153 | Geomorphology |
| GEL 154 | Environmental Geomorphology |
| GEO 106 | Aerial Photo Interpretation and Remote Sensing |
| SSC 107 | Soil Physics |
| STA 205 | Statistical Methods for Research |

# Irrigation and Drainage Systems Specialization

This specialization of Hydrology considers the study of water conservation and management in irrigated agriculture, innovative water distribution and application methods, energy requirements, soil-plant-water relationships, water quality, surface and subsurface drainage, seepage, wells and pumps.

List of Available Courses (not including core courses listed on page 3)

| | |
|---|---|
| WSC 100 | Principles of Hydrologic Science |
| WSC 103 | Water Quality, Salt Control and Reclamation |
| WSC 104 | Plant-Water-Soil Relationships |
| WSC 110 | Irrigation Principles and Practices |
| WSC 145 | Irrigation and Drainage Systems (same as ENA 145) |
| WSC 149B & 149L | Groundwater Hydrology |
| WSC 154 | Water and Related Resource Allocation from Economic Principles |
| WSC 172 | Farm Irrigation Management |
| WSC 200 | Hydrologic Modeling in the Vadose Zone |
| WSC 201 | Advanced Plant-Water Relations |
| WSC 202 | Evapotranspiration |
| WSC 206 | Water Resources Systems Analysis (or ECI 273) |
| WSC 215 | Advanced Topics in Water and Soil Chemistry |
| WSC 250 | Advanced Soil Physics |
| WSC 255 | Analysis of Random Fields |
| WSC 291 | Seminar in Water-Soil-Plant Relations and Irrigation |
| AGE 176 | Economic Analysis in Resource Use |
| AGE 253 | Linear Programming Analysis of Operational Problems |
| ATM 133 | Biometeorology |
| ECI 145 | Hydraulic Structure Design |
| ECI 146 | Water Resources Simulation |
| ECI 212A | Finite Element Procedures in Applied Mechanics |
| ECI 212C | Finite Elements: Application to Fluid Problems |
| ECI 267 | Water Resources Management |
| ECI 272A & 272B | Advanced Groundwater Hydrology |
| ECI 275 | Hydrologic Time-Series Analysis |
| ECI 277 | Unsteady Flow in Open Channels |
| ENA 145 | Irrigation and Drainage Systems |
| ENA 240 | Infiltration and Drainage |
| ENA 241 | Sprinkle and Trickle Irrigation Systems |
| ENA 242 | Surface Irrigation Hydraulics |
| HYS 220 | Numerical Modeling of Groundwater Systems |
| HYS 230 | Introduction to Geostatistics |
| SSC 107 | Soil Physics |
| SSC 122 | Salt-Affected Soils |
| SSC 207 | Transport Process in Soils |

# *HYDROGEOCHEMISTRY OPTION*

The Hydrogeochemistry option provides students with a quantitative understanding of chemically-based processes in hydrogeochemical environments and complementary physical and biological processes and conditions. Through careful selection of their courses in consultation with their Faculty Advisor, students may specialize in the inorganic chemistry aspects of natural systems, the fate and transport of organic contaminants, or a combination of these two areas appropriate to the student's research, or application interests. Students interested in the inorganic aspect may study the behavior of inorganic chemical species in water and the dissolution/precipitation reactions occurring during mineral-fluid interactions in the subsurface and atmosphere. Course topics would include kinetics and equilibria of geochemical reactions, movement of isotopes and soil chemistry. Students may also consider study of the transport, transformation and degradation of organic chemicals in the hydrosphere with particular emphasis on the subsurface environment.

List of Available Courses (not including core courses listed on page 3)

| | |
|---|---|
| WSC 103 | Water Quality, Salt Control and Reclamation |
| WSC 149B & 149L | Groundwater Hydrology |
| WSC 200 | Hydrologic Modeling in the Vadose Zone |
| WSC 215 | Advanced Topics in Water and Soil Chemistry |
| WSC 217 | Hydrochemical Models |
| ATM 149 | Introduction to Air Pollution (same as ECI 149) |
| ATM 231 | Advanced Air Pollution Meteorology |
| CHE 115 | Instrumental Analysis |
| CHE 124A, B & C | Inorganic Chemistry |
| CHE 128A, B & C | Organic Chemistry |
| ECH 254 | Colloid and Surface Phenomena |
| ECI 140 & 140L | Environmental Analysis of Aqueous Systems |
| ECI 149 | Introduction to Air Pollution |
| ECI 174 | Environmental Geotechnology |
| ECI 240 | Water Quality |
| ECI 242A | Air Quality |
| ECI 242B | Airborne Particles and Scavenging Mechanisms |
| ECI 244 | Environmental Quality Modeling |
| ECI 245 | Applied Environmental Chemistry |
| ECI 272A & 272B | Advanced Groundwater Hydrology |
| ECI 283 | Physicochemical Influences and In-Situ Evaluation of Soil Behavior |
| ETX 101 | Principles of Environmental Toxicology |
| ETX 112A & 112B | Toxicants in the Environment |
| ETX 132 | Chromatography for Analytical Toxicology |
| ETX 228 | Gas Chromatograph |
| ETX 240 | Ecotoxicology |
| GEL 215A | Geochronology |
| GEL 215B | Stable Isotope Geochemistry |
| HYS 220 | Numerical Modeling of Groundwater Systems |
| HYS 230 | Introduction to Geostatistics |
| HYS 240 | Multiphase Flow in Soils |
| SSC 107 | Soil Physics |
| SSC 111 | Geomicrobiology |
| SSC 207 | Transport Process in Soils |
| SSC 211 | Advanced Soil Microbiology |
| SSC 214 | Soil Mineralogy |
| SSC 215 | Physical Chemistry of Soils |
| SSC 2xx | Mineral Fluid Reactions (W. Casey) |