

LAND, AIR, & WATER RESOURCES

College of Agricultural & Environmental Sciences

William Horwath, Ph.D., Chairperson

Department Office

1110 Plant & Environmental Sciences Building; 530-752-1130; Land, Air, & Water Resources (<http://lawr.ucdavis.edu>)

Land, Air & Water Resources is a multidisciplinary department with faculty who specialize in atmospheric science, plant science, soils and biogeochemistry, hydrology, and water engineering. Teaching, research, and outreach efforts focus on agricultural and environmental aspects of these disciplines. The faculty also contributes to numerous other undergraduate and graduate programs in the Colleges of Agricultural & Environmental Sciences, Letters & Science, and Engineering.

Major Programs

Undergraduate programs in Atmospheric Science (<https://catalog.ucdavis.edu/departments-programs-degrees/land-air-water-resources/atmospheric-science-bs/>), Hydrology (<https://catalog.ucdavis.edu/departments-programs-degrees/land-air-water-resources/hydrology-bs/>), Environmental Science & Management (<https://catalog.ucdavis.edu/departments-programs-degrees/environmental-science-policy/environmental-science-management-bs/>), and Sustainable Agriculture & Food Systems (<https://catalog.ucdavis.edu/departments-programs-degrees/land-air-water-resources/sustainable-agriculture-food-systems-bs/>) are centered in the department; see Undergrad Programs (<https://lawr.ucdavis.edu/students/undergrad-programs/>).

Undergraduate Advising Center is located in 1150 Plant & Environmental Sciences Building; 530-752-1603.

Courses

See courses listed under Atmospheric Science (ATM) (<https://catalog.ucdavis.edu/courses-subject-code/>), Hydrologic Sciences (HYD) (<https://catalog.ucdavis.edu/courses-subject-code/>), Hydrology (HYD) (<https://catalog.ucdavis.edu/courses-subject-code/>), Environmental Science & Management (ESM) (<https://catalog.ucdavis.edu/courses-subject-code/>), and Soil Science (SSC) (<https://catalog.ucdavis.edu/courses-subject-code/>). See also the websites listed above.

Graduate Study

Graduate programs, offering both M.S. and Ph.D. degrees, in Atmospheric Science (<https://catalog.ucdavis.edu/departments-programs-degrees/land-air-water-resources/atmospheric-science-bs/>), Soils & Biogeochemistry (<https://catalog.ucdavis.edu/departments-programs-degrees/soils-biogeochemistry-graduate-group/>), and Hydrologic Sciences (<https://catalog.ucdavis.edu/departments-programs-degrees/hydrologic-sciences-graduate-group/>) are administered in the department; see Grad Programs (http://lawr.ucdavis.edu/academic_programs.htm).

Graduate Advising Center is located in 1152 Plant & Environmental Sciences Building; 530-752-1669.

- Atmospheric Science, Bachelor of Science (<https://catalog.ucdavis.edu/departments-programs-degrees/land-air-water-resources/atmospheric-science-bs/>)
- Atmospheric Science, Minor (<https://catalog.ucdavis.edu/departments-programs-degrees/land-air-water-resources/atmospheric-science-minor/>)
- Hydrology, Bachelor of Science (<https://catalog.ucdavis.edu/departments-programs-degrees/land-air-water-resources/hydrology-bs/>)
- Hydrology, Minor (<https://catalog.ucdavis.edu/departments-programs-degrees/land-air-water-resources/hydrology-minor/>)
- International Science Studies, Minor (<https://catalog.ucdavis.edu/departments-programs-degrees/land-air-water-resources/international-science-studies-minor/>)
- Soil Science, Minor (<https://catalog.ucdavis.edu/departments-programs-degrees/land-air-water-resources/soil-science-minor/>)
- Sustainable Agriculture & Food Systems, Bachelor of Science (<https://catalog.ucdavis.edu/departments-programs-degrees/land-air-water-resources/sustainable-agriculture-food-systems-bs/>)
- Watershed Science, Minor (<https://catalog.ucdavis.edu/departments-programs-degrees/land-air-water-resources/watershed-science-minor/>)

Atmospheric Science (ATM)

ATM 005 – Global Climate Change (3 units)

Course Description: Scientific concepts needed to understand climate and climate change. Principles of regional variations in climate. Understanding observed seasonal, decadal and millennial changes. Analysis of the Antarctic ozone hole, El Nino and human-induced global warming.

Learning Activities: Lecture 2 hour(s), Discussion 1 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL).

ATM 006 – Fundamentals of Atmospheric Pollution (3 units)

Course Description: Effects of human emissions on the atmosphere: smog, ozone pollution, and ozone depletion; indoor air pollution; global warming; acid rain. Impacts of these problems on the earth, ecosystems, and humans. Strategies to reduce atmospheric pollution.

Learning Activities: Lecture 3 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Scientific Literacy (SL); Visual Literacy (VL).

ATM 010 – Severe & Unusual Weather (3 units)

Course Description: Introduction to physical principles of severe and unusual weather: flood, blizzards, thunderstorms, lightning, tornadoes, and hurricanes. Emphasis on scientific perspective and human context. Not open to students who have received credit for ATM 100. (Former ATM 100.)

Prerequisite(s): High school physics.

Learning Activities: Lecture 2 hour(s), Discussion 1 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL).

ATM 060 – Introduction to Atmospheric Science (4 units)

Course Description: Fundamental principles of the physics, chemistry, and fluid dynamics underlying weather and climate. Solar radiation, the greenhouse effect, and the thermal budget of the Earth. Clouds and their formation, convection, precipitation, mid-latitude storm systems.

Prerequisite(s): (MAT 016A or MAT 021A); (PHY 007A or PHY 009A).

Learning Activities: Lecture 3 hour(s), Discussion 1 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Visual Literacy (VL).

ATM 092 – Atmospheric Science Internship (1-12 units)

Course Description: Internship off and on campus in atmospheric science. Internship supervised by a member of the faculty.

Prerequisite(s): Consent of instructor; lower division standing.

Learning Activities: Internship 3-36 hour(s).

Grade Mode: Pass/No Pass only.

ATM 098 – Directed Group Study (1-5 units)

Course Description: Directed group study.

Prerequisite(s): Consent of instructor.

Learning Activities: Variable.

Grade Mode: Pass/No Pass only.

ATM 099 – Special Study for Undergraduates (1-5 units)

Course Description: Special study for undergraduates.

Learning Activities: Variable.

Grade Mode: Pass/No Pass only.

ATM 110 – Weather Observation & Analysis (4 units)

Course Description: Acquisition, distribution and analysis of meteorological data. Vertical sounding analysis, stability indices, probability of local severe weather, weather map analysis. Use of National Weather Service analyses and forecast products. Laboratory makes use of computer-generated analyses.

Prerequisite(s): ATM 060.

Learning Activities: Lecture 3 hour(s), Laboratory 3 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Oral Skills (OL);

Quantitative Literacy (QL); Visual Literacy (VL).

ATM 111 – Weather Analysis & Prediction (3 units)

Course Description: Tools for analyzing observed properties of mid-latitude weather systems. The analysis-forecast system, including various weather forecast models. General structure and properties of mid-latitude weather systems.

Prerequisite(s): ATM 110; ATM 121B; (ATM 111L (can be concurrent) or ATM 111LY (can be concurrent)); knowledge of a programming language.

Learning Activities: Lecture 3 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Visual Literacy (VL).

ATM 111LY – Weather Analysis & Prediction Laboratory (2 units)

Course Description: Subjective and objective analysis of weather data. Web-based learning of the analysis-forecast system and various weather forecasting situations. Weather map interpretation and forecast discussions.

Prerequisite(s): ATM 111 (can be concurrent).

Learning Activities: Laboratory 2 hour(s), Web Virtual Lecture 4 hour(s).

Grade Mode: Pass/No Pass only.

General Education: Science & Engineering (SE); Oral Skills (OL);

Quantitative Literacy (QL); Visual Literacy (VL).

ATM 112 – Weather Forecasting Practice (2 units)

Course Description: Formal practice in preparing local weather forecasts. Analysis of current weather conditions and recent model performance. Verification and discussion of prior forecast. Interpretation of current forecast model guidance. Posting of forecast.

Prerequisite(s): ATM 110.

Learning Activities: Discussion 2 hour(s), Laboratory 1 hour(s).

Repeat Credit: May be repeated 3 time(s).

Grade Mode: Pass/No Pass only.

ATM 115 – Hydroclimatology (3 units)

Course Description: Examination of climate as the forcing function for the hydrologic system. Emphasis on seasonal variations in the relationship between precipitation and evapotranspiration for meso-scale areas. Watershed modeling of floods and drought for evaluating the effects of climatic fluctuations.

Prerequisite(s): ATM 060.

Learning Activities: Lecture 3 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Scientific Literacy (SL).

ATM 116 – Modern Climate Change (3 units)

Course Description: Factors that determine the Earth's climate, including natural and human-caused changes. Impacts of climate change. Possible future climates and policies to reduce human emissions of greenhouse gases.

Learning Activities: Lecture 3 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL);

Scientific Literacy (SL); Visual Literacy (VL).

ATM 120 – Atmospheric Thermodynamics & Cloud Physics (4 units)

Course Description: Atmospheric composition and structure, thermodynamics of atmospheric gases, thermal properties of dry and moist air, atmospheric stability; cloud nucleation, cloud growth by condensation and collision, cloud models.

Prerequisite(s): MAT 021C; PHY 009B; ATM 060 (can be concurrent).

Learning Activities: Lecture 3 hour(s), Extensive Problem Solving 3 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL);

Visual Literacy (VL).

ATM 121A – Atmospheric Dynamics (4 units)

Course Description: Fundamental forces of atmospheric flow; noninertial reference frames; development of the equations of motion for rotating stratified atmospheres; isobaric and natural coordinate systems; geostrophic flow; thermal wind; circulation and vorticity.

Prerequisite(s): ATM 120; MAT 021D; PHY 009B.

Learning Activities: Lecture 3 hour(s), Extensive Problem Solving.

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL).

ATM 121B – Atmospheric Dynamics (4 units)

Course Description: Dynamics of fluid motion in geophysical systems; quasi-geostrophic theory; fundamentals of wave propagation in fluids; Rossby waves; gravity waves; fundamentals of hydrodynamic instability; two-level model; baroclinic instability and cyclogenesis.

Prerequisite(s): ATM 121A.

Learning Activities: Lecture 3 hour(s), Extensive Problem Solving.

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL).

ATM 124 – Meteorological Instruments & Observations (3 units)

Course Description: Modern meteorological instruments and their use in meteorological observations and measurements. Both standard and micrometeorological instruments are included.

Prerequisite(s): ATM 060.

Learning Activities: Lecture 2 hour(s), Laboratory 3 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL).

ATM 128 – Radiation & Satellite Meteorology (4 units)

Course Description: Concepts of atmospheric radiation and the use of satellites in remote sensing. Emphasis on the modification of solar and infrared radiation by the atmosphere. Estimation from satellite data of atmospheric variables such as temperatures and cloudiness.

Prerequisite(s): ATM 060; PHY 009B; MAT 022B; MAT 021D.

Learning Activities: Discussion/Laboratory 3 hour(s), Extensive Problem Solving 1 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Visual Literacy (VL).

ATM 133 – Biometeorology (4 units)

Course Description: Atmospheric and biological interactions. Physical and biological basis for water vapor, carbon dioxide and energy exchanges with the atmosphere associated with plants and animals, including humans. Microclimate of plant canopies and microclimatic modification such as frost protection and windbreaks.

Prerequisite(s): MAT 016B; one course in a biological discipline or consent of instructor.

Learning Activities: Lecture 3 hour(s), Discussion 1 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL).

ATM 149 – Air Pollution (4 units)

Starting Winter Quarter 2024, this course is no longer offered.

Course Description: Physical and technical aspects of air pollution. Factors that determine local, regional, and global air quality; climate change; and physical and chemical properties of pollutants.

Prerequisite(s): MAT 021D; (MAT 022B or MAT 027B); CHE 002B C- or better; (ATM 121A or ENG 103 C- or better or ECI 100 C- or better).

Learning Activities: Lecture 3 hour(s), Laboratory 3 hour(s).

Cross Listing: ECI 149.

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL).

ATM 149N – Air Pollution (4 units)

Course Description: Physical and technical aspects of air pollution. Factors that determine local, regional, and global air quality; climate change; and physical and chemical properties of pollutants.

Prerequisite(s): MAT 021D; (MAT 022B or MAT 027B); CHE 002B C- or better; (ATM 121A or ENG 103 C- or better or ECI 100 C- or better).

Learning Activities: Discussion 1 hour(s), Lecture 3 hour(s).

Cross Listing: ECI 149N.

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL).

ATM 150 – Introduction to Computer Methods in Physical Sciences (4 units)

Course Description: Computational techniques used in physical sciences. Integral and differential equation numerical solution: mainly finite differencing and spectral (Fourier transform) methods. Time series applications (time-permitting). Specific applications drawn from meteorology. Accelerated introduction to FORTRAN including programming assignments.

Prerequisite(s): MAT 022B; PHY 009B; computer programming course such as ECS 030; additional courses in fluid dynamics (ATM 121A or ENG 103) and in Fourier transforms (MAT 118C or PHY 104A) helpful but not required.

Learning Activities: Lecture 3 hour(s), Discussion/Laboratory 2 hour(s).

Enrollment Restriction(s): Enrollment limited to 12, preference to Atmospheric Science majors.

Grade Mode: Pass/No Pass only.

General Education: Science & Engineering (SE).

ATM 158 – Boundary-Layer Meteorology (4 units)

Course Description: Dynamics of the atmosphere nearest the Earth's surface. Friction and heat transfer. Properties of turbulent flows; statistical and spectral techniques; use and interpretation of differential equations. Emphasis on the importance to weather, air pollution, and the world's oceans.

Prerequisite(s): ATM 121A.

Learning Activities: Lecture 3 hour(s), Discussion 1 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Visual Literacy (VL).

ATM 160 – Introduction to Atmospheric Chemistry (4 units)

Course Description: Quantitative examination of current local, regional and global problems in atmospheric chemistry (including photochemical smog, acid deposition, climate change, and stratospheric ozone depletion) using fundamental concepts from chemistry. Basic chemical modeling of atmospheric reaction systems.

Prerequisite(s): CHE 002B.

Learning Activities: Lecture 3 hour(s), Discussion 1 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL).

ATM 192 – Atmospheric Science Internship (1-12 units)

Course Description: Internship off and on campus in atmospheric science. Internship supervised by a member of the faculty.

Prerequisite(s): Consent of instructor. Completion of 84 units.

Learning Activities: Internship 3-36 hour(s).

Grade Mode: Pass/No Pass only.

ATM 198 – Directed Group Study (1-5 units)

Course Description: Directed group study.

Prerequisite(s): Consent of instructor; three upper division units in Atmospheric Science.

Learning Activities: Variable.

Grade Mode: Pass/No Pass only.

ATM 199 – Special Study for Advanced Undergraduates (1-5 units)

Course Description: Special study for advanced undergraduates.

Prerequisite(s): Consent of instructor; three upper division units in Atmospheric Science and at least an overall B average.

Learning Activities: Variable.

Grade Mode: Pass/No Pass only.

ATM 215 – Advanced Hydroclimatology (3 units)

Course Description: Theoretical and applied aspects of energy and mass fluxes linking the earth's surface, atmosphere, and hydrologic system. Emphasis on regional scale analysis and modeling, spatial data representation, and climate change influences on precipitation and its hydroclimatic expression.

Prerequisite(s): ATM 115.

Learning Activities: Lecture 3 hour(s).

Grade Mode: Letter.

ATM 221 – Advanced Atmospheric Dynamics (3 units)

Course Description: Conditions for instability in stratified atmospheres; baroclinic instability; forced topographic Rossby Waves; wave-mean flow interaction theory; tropical dynamics; stratospheric dynamics.

Prerequisite(s): ATM 121B.

Learning Activities: Lecture 3 hour(s).

Grade Mode: Letter.

ATM 223 – Advanced Boundary-Layer Meteorology (3 units)

Course Description: Characteristics of the atmospheric boundary layer under convective and nocturnal conditions. Heat budget at the surface and boundary layer forcing. Similarity theory and scaling of the boundary layer. Measurement and simulation techniques.

Prerequisite(s): ATM 230.

Learning Activities: Lecture 3 hour(s).

Grade Mode: Letter.

ATM 230 – Atmospheric Turbulence (3 units)

Course Description: Dynamics and energetics of turbulence in the atmosphere including vorticity dynamics. Statistical description of turbulence; Eulerian and Lagrangian scales, spectral analysis, conditional sampling techniques. Turbulent diffusion; the closure problem, gradient-diffusion and second-order methods.

Prerequisite(s): ATM 121B or ATM 158.

Learning Activities: Lecture 3 hour(s).

Grade Mode: Letter.

ATM 231 – Advanced Air Pollution Meteorology (3 units)

Course Description: Processes determining transport and diffusion of primary and secondary pollutants. Models of chemical transformation, of the atmospheric boundary layer and of mesoscale wind fields, as applicable to pollutant dispersion problems.

Prerequisite(s): ATM 160; ATM 149A; course in fluid dynamics.

Learning Activities: Lecture 3 hour(s).

Grade Mode: Letter.

ATM 233 – Advanced Biometeorology (3 units)

Course Description: Current topics in biometeorology. Physical and biological basis for water vapor, other gases, and energy exchange with the atmosphere. Topics include modeling and measuring turbulent transport from plant canopies, surface temperatures and energy budgets, bio-aerosol physics and aerobiology.

Prerequisite(s): ATM 133; or consent of instructor.

Learning Activities: Lecture/Discussion 3 hour(s).

Grade Mode: Letter.

ATM 240 – General Circulation of the Atmosphere (4 units)

Course Description: Large-scale, observed atmospheric properties. Radiation, momentum, and energy balances derived and compared with observations. Lectures and homework synthesize observations and theories, then apply them to understand the large-scale circulations.

Prerequisite(s): ATM 121B.

Learning Activities: Lecture/Discussion 4 hour(s).

Grade Mode: Letter.

ATM 241 – Climate Dynamics (3 units)

Course Description: Dynamics of large-scale climatic variations over time periods from weeks to centuries. Description of the appropriate methods of analysis of atmospheric and oceanic observations. Conservation of mass, energy and momentum. Introduction to the range of climate simulations.

Prerequisite(s): ATM 121B.

Learning Activities: Lecture/Discussion 3 hour(s).

Grade Mode: Letter.

ATM 244 – Cloud & Precipitation Physics (3 units)

Course Description: Observations and modeling of clouds and precipitation. Physics and parameterization of cloud microphysical processes including nucleation, condensation/evaporation, deposition/sublimation, collision-coalescence and sedimentation.

Learning Activities: Lecture 3 hour(s).

Enrollment Restriction(s): Restricted to Atmospheric Science graduate group students or consent of instructor.

Grade Mode: Letter.

ATM 245 – Climate Change, Water & Society (4 units)

Course Description: Integration of climate science and hydrology with policy to understand hydroclimatology and its impact upon natural and human systems. Assignments: readings, take-home examination on climate and hydrologic science, paper that integrates course concepts into a research prospectus or review article.

Learning Activities: Lecture 4 hour(s).

Enrollment Restriction(s): Limited to 25 students.

Cross Listing: HYD 245, ECL 245.

Grade Mode: Letter.

ATM 250 – Meso-Scale Meteorology (3 units)

Course Description: The study of weather phenomena with horizontal spatial dimensions between 2.5 and 2500 kilometers. Methods of observational study and numerical modeling of the structure and temporal behavior of these weather systems.

Prerequisite(s): ATM 150; graduate standing; course in partial differential equations or consent of instructor.

Learning Activities: Lecture 3 hour(s).

Grade Mode: Letter.

ATM 255 – Numerical Modeling of the Atmosphere (4 units)

Course Description: Principles of numerical modeling of the dynamic, thermodynamic and physical processes of the atmosphere. Hands-on experiments on model development using the shallow water equations and the primitive equations. Operational forecast models.

Prerequisite(s): ATM 121B; ENG 005; ATM 150 recommended.

Learning Activities: Lecture 2 hour(s), Laboratory 6 hour(s).

Grade Mode: Letter.

ATM 260 – Atmospheric Chemistry (3 units)

Course Description: Chemistry and photochemistry in tropospheric condensed phases (fog, cloud, and rain drops and aerosol particles). Gas-drop and gas-particle partitioning of compounds and effects of reactions in condensed phases on the fates and transformations of tropospheric chemical species.

Prerequisite(s): ATM 160.

Learning Activities: Lecture 3 hour(s).

Grade Mode: Letter.

ATM 265 – The Art of Climate Modeling (4 units)

Course Description: Over the past fifty years, global models have given us incredible insight into the Earth system. Provides an introduction to these models, with a focus on their design and the science questions they have been built to address.

Prerequisite(s): ATM 121A.

Learning Activities: Lecture 3 hour(s), Project.

Grade Mode: Letter.

ATM 270A – Topics in Atmospheric Science: Meteorological Statistics (1-3 units)

Course Description: Applications and concepts in meteorological statistics.

Learning Activities: Discussion 1-3 hour(s).

Grade Mode: Letter.

ATM 270B – Topics in Atmospheric Science: Computer Modeling of the Atmosphere (1-3 units)

Course Description: Applications and concepts in computer modeling of the atmosphere.

Learning Activities: Discussion 1-3 hour(s).

Grade Mode: Letter.

ATM 270C – Topics in Atmospheric Science: Design of Experiments & Field Studies in Meteorology (1-3 units)

Course Description: Applications and concepts in design of experiments and field studies in meteorology.

Learning Activities: Discussion 1-3 hour(s).

Grade Mode: Letter.

ATM 270D – Topics in Atmospheric Science: Solar & Infrared Radiation in the Atmosphere (1-3 units)

Course Description: Applications and concepts in solar and infrared radiation in the atmosphere.

Learning Activities: Discussion 1-3 hour(s).

Grade Mode: Letter.

ATM 270E – Topics in Atmospheric Science: Aerosol & Cloud Physics (1-3 units)

Course Description: Applications and concepts in aerosol and cloud physics.

Learning Activities: Discussion 1-3 hour(s).

Grade Mode: Letter.

ATM 270F – Topics in Atmospheric Science: Atmospheric Chemistry (1-3 units)

Course Description: Applications and concepts in atmospheric chemistry.

Learning Activities: Discussion 1-3 hour(s).

Grade Mode: Letter.

ATM 270G – Topics in Atmospheric Science: General Meteorology (1-3 units)

Course Description: Applications and concepts in general meteorology.

Learning Activities: Discussion 1-3 hour(s).

Grade Mode: Letter.

ATM 280A – Air Quality Policy in the Real World (4 units)

Course Description: In-depth investigation of an air quality problem with a team and mentor from government or industry. Science, engineering and policy will be involved. Findings will be presented orally and in writing.

Prerequisite(s): (ATM 149 or ECI 149); ECI 242; consent of instructor, or equivalent of ECI 242.

Learning Activities: Project.

Grade Mode: Letter.

ATM 280B – Air Quality Policy in the Real World (4 units)

Course Description: In-depth investigation of an air quality problem with a team and mentor from government or industry. Science, engineering and policy will be involved. Findings will be presented orally and in writing.

Prerequisite(s): ATM 280A; and consent of instructor.

Learning Activities: Project.

Grade Mode: Letter.

ATM 290 – Seminar (1 unit)

Course Description: Current developments in selected areas of atmospheric research. Topics will vary according to student and faculty interests.

Prerequisite(s): Graduate standing in Atmospheric Science or related field.

Learning Activities: Seminar 1 hour(s).

Grade Mode: Satisfactory/Unsatisfactory only.

ATM 291A – Research Conference in Atmospheric Science: Air Quality Meteorology (1-3 units)

Course Description: Review and discussion of current literature and research in Air Quality Meteorology.

Prerequisite(s): Consent of instructor.

Learning Activities: Lecture/Discussion 1-3 hour(s).

Repeat Credit: May be repeated 6 unit(s).

Grade Mode: Satisfactory/Unsatisfactory only.

ATM 291B – Research Conference in Atmospheric Science: Biometeorology (1-3 units)

Course Description: Review and discussion of current literature and research in Biometeorology.

Prerequisite(s): Consent of instructor.

Learning Activities: Lecture/Discussion 1-3 hour(s).

Repeat Credit: May be repeated 6 unit(s).

Grade Mode: Satisfactory/Unsatisfactory only.

ATM 291C – Research Conference in Atmospheric Science: Boundary Layer Meteorology (1-3 units)

Course Description: Review and discussion of current literature and research in Boundary Layer Meteorology.

Prerequisite(s): Consent of instructor.

Learning Activities: Lecture/Discussion 1-3 hour(s).

Repeat Credit: May be repeated 6 unit(s).

Grade Mode: Satisfactory/Unsatisfactory only.

ATM 291D – Research Conference in Atmospheric Science: Climate Change (1-3 units)

Course Description: Review and discussion of current literature and research in Climate Change.

Prerequisite(s): Consent of instructor.

Learning Activities: Lecture/Discussion 1-3 hour(s).

Repeat Credit: May be repeated 6 unit(s).

Grade Mode: Satisfactory/Unsatisfactory only.

ATM 291E – Research Conference in Atmospheric Science: General Meteorology (1-3 units)

Course Description: Review and discussion of current literature and research in General Meteorology.

Prerequisite(s): Consent of instructor.

Learning Activities: Lecture/Discussion 1-3 hour(s).

Repeat Credit: May be repeated 6 unit(s).

Grade Mode: Satisfactory/Unsatisfactory only.

ATM 291F – Research Conference in Atmospheric Science: Atmospheric Chemistry (1-3 units)

Course Description: Review and discussion of current literature and research in Atmospheric Chemistry.

Prerequisite(s): Consent of instructor.

Learning Activities: Lecture/Discussion 1-3 hour(s).

Repeat Credit: May be repeated 6 unit(s).

Grade Mode: Satisfactory/Unsatisfactory only.

ATM 298 – Group Study (1-5 units)

Course Description: Group study.

Prerequisite(s): Consent of instructor; graduate standing.

Learning Activities: Variable.

Grade Mode: Satisfactory/Unsatisfactory only.

ATM 299 – Research (1-12 units)

Course Description: Research.

Prerequisite(s): Consent of instructor. Graduate standing.

Learning Activities: Variable.

Grade Mode: Satisfactory/Unsatisfactory only.

ATM 393 – Teaching Assistant Training Practicum (1-4 units)

Course Description: Teaching assistant training practicum.

Prerequisite(s): Graduate standing.

Learning Activities: Variable.

Repeat Credit: May be repeated.

Grade Mode: Pass/No Pass only.

ATM 396 – Teaching Assistant Training Practicum (1-4 units)

Course Description: Teaching assistant training practicum.

Prerequisite(s): Graduate standing.

Learning Activities: Variable.

Repeat Credit: May be repeated.

Grade Mode: Pass/No Pass only.

Hydrologic Science (HYD)

HYD 010 – Water, Power, Society (3 units)

Course Description: Water resources issues. How water has been used to gain and wield socio-political power. Water resources development in California as related to current and future sustainability of water quantity and quality. Roles of science and policy in solving water problems.

Learning Activities: Lecture 2 hour(s), Discussion 1 hour(s).

Cross Listing: SAS 010.

Grade Mode: Letter.

General Education: Science & Engineering (SE) or Social Sciences (SS); Scientific Literacy (SL).

HYD 092 – Hydrologic Science Internship (1-12 units)

Course Description: Work experience off and on campus in Hydrologic Science. Internship supervised by a member of the faculty.

Prerequisite(s): Consent of instructor; lower division student.

Learning Activities: Internship 3-36 hour(s).

Grade Mode: Pass/No Pass only.

HYD 098 – Directed Group Study (1-5 units)

Course Description: Directed group study.

Prerequisite(s): Consent of instructor.

Learning Activities: Variable.

Grade Mode: Pass/No Pass only.

HYD 103N – Fluid Mechanics Fundamentals (4 units)

Course Description: Fluid mechanics axioms, fluid statics, kinematics, velocity fields for one-dimensional incompressible flow and boundary layers, turbulent flow time averaging, potential flow, dimensional analysis, and macroscopic balances to solve a range of practical problems.

Prerequisite(s): PHY 009B.

Learning Activities: Lecture 4 hour(s).

Cross Listing: EBS 103.

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Visual Literacy (VL).

HYD 110 – Irrigation Systems & Water Management (4 units)

Course Description: Soil and plant aspects of irrigation and drainage. Soil-water principles including water storage and movement, plant response to irrigation, water use by crops, irrigation systems (i.e., micro-irrigation, sprinkler irrigation and surface irrigation), and related salinity and water quality impacts.

Prerequisite(s): PHY 007A; SSC 100 recommended.

Learning Activities: Lecture 3 hour(s), Laboratory 3 hour(s).

Cross Listing: ABT 110, ESM 110.

Grade Mode: Letter.

General Education: Science & Engineering (SE); Scientific Literacy (SL).

HYD 118 – Evapotranspiration Principles, Measurement & Modeling (4 units)

Course Description: Estimation of evapotranspiration (ET) for irrigation management and water resources planning; including the basic principles and key factors controlling evaporation and ET rates, methods of measuring these factors in the field and remotely, and determination of likely water requirements for crops and various landscape conditions as needed for water resources planning.

Prerequisite(s): HYD 124 C or better; consent of instructor.

Learning Activities: Lecture 3 hour(s), Laboratory 3 hour(s).

Cross Listing: ESM 118; EBS 148.

Grade Mode: Letter.

General Education: Science & Engineering (SE).

HYD 124 – Plant-Water-Soil Relationships (4 units)

Course Description: Principles of plant interactions with soil and atmospheric water environments and practical applications to crop management (e.g., irrigation) and plant eco-physiology (e.g., drought).

Prerequisite(s): (SSC 100 (can be concurrent) or SSC 107 (can be concurrent)); (PLS 100A (can be concurrent) or PLB 111 (can be concurrent)); or consent of instructor.

Learning Activities: Lecture 3 hour(s), Discussion 1 hour(s).

Credit Limitation(s): Not open for credit to students who have completed WSC 104.

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL).

HYD 134 – Aqueous Geochemistry (6 units)

Course Description: Chemistry of natural waters; dielectric properties of water; thermodynamic and mass-action relations; metal hydrolysis; acid-base equilibria; metal-coordination chemistry; solubility calculations; electron-exchange reactions; sorptive partitioning; ion exchange; and dissolved organic matter.

Prerequisite(s): CHE 002B.

Learning Activities: Lecture 4 hour(s), Laboratory 3 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL).

HYD 141 – Physical Hydrology (4 units)

Course Description: Introduction to the processes that constitute the hydrologic cycle. Special emphasis on a quantitative description of the following processes: precipitation, infiltration, evaporation, transpiration, surface runoff, and groundwater runoff.

Prerequisite(s): PHY 009B; MAT 021B; HYD 100 recommended.

Learning Activities: Lecture 3 hour(s), Discussion 1 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL).

HYD 142 – Systems Hydrology (4 units)

Course Description: General course considering hydrologic processes from a systems or statistical model perspective. General probability concepts are applied to frequency, time series and spatial data analysis. Linear systems are also considered in conjunction with Kalman filter techniques.

Prerequisite(s): HYD 141 or ECI 142.

Learning Activities: Lecture 3 hour(s), Discussion 1 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Oral Skills (OL); Quantitative Literacy (QL).

HYD 143 – Ecohydrology (4 units)

Course Description: Movement and storage of water in individual ecosystems and the integrated functioning of water and biota at the watershed scale.

Prerequisite(s): HYD 010 or HYD 141 or ESP 001 or ESM 100 or ESM 108 or ESM 120 or GEL 001 or GEL 050 or SSC 100; or consent of instructor.

Learning Activities: Lecture/Discussion 3 hour(s), Extensive Problem Solving.

Grade Mode: Letter.

General Education: Science & Engineering (SE); Oral Skills (OL); Quantitative Literacy (QL); Scientific Literacy (SL).

HYD 144 – Groundwater Hydrology (4 units)

Course Description: Global role of groundwater resources in society; groundwater in the hydrologic cycle; geology of groundwater; global, US, and California geography of groundwater; physical measures of groundwater occurrence and flow; water balance; modeling groundwater flow; principles of well construction; aquifer tests; groundwater quality; contaminant transport and monitoring; groundwater law, water quality regulations, and sustainable management.

Prerequisite(s): MAT 012 (can be concurrent) or MAT 016B (can be concurrent) or MAT 021A (can be concurrent).

Learning Activities: Lecture 3 hour(s), Discussion 1 hour(s).

Cross Listing: EBS 144.

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL); Writing Experience (WE).

HYD 145 – Water Science & Design (4 units)

Course Description: Introduction to watershed engineering, storm water management, design of hydraulic systems. Topics include hydrological risk analysis, flood routing, design storms, open channel flow, pipes, culverts, spillways, and detention basins. Class project and field trips will apply theory to real-life problems.

Prerequisite(s): (HYD 141 or ESM 100); (MAT 016B or MAT 021B); or consent of instructor.

Learning Activities: Lecture 3 hour(s), Laboratory 3 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Writing Experience (WE).

HYD 146 – Hydrogeology & Contaminant Transport (5 units)

Course Description: Physical and chemical processes affecting groundwater flow and contaminant transport, with emphasis on realistic hydrogeologic systems. Groundwater geology and chemistry. Fundamentals of groundwater flow and transport analysis. Laboratory includes field pumping test and work with physical and computer models.

Prerequisite(s): HYD 144 or ECI 144; or the equivalent.

Learning Activities: Lecture 3 hour(s), Laboratory 2 hour(s), Term Paper 1 hour(s).

Cross Listing: GEL 156.

Grade Mode: Letter.

General Education: Science & Engineering (SE).

HYD 147 – Runoff, Erosion & Water Quality Management (3 units)

Course Description: Practical hydrology and runoff water quality management from disturbed watersheds. Development of hillslope and soils restoration concepts and practice, modeling and application.

Prerequisite(s): (PHY 007B or PHY 009B); (MAT 016C or MAT 017C or MAT 021C); (ECI 142 or HYD 141 or ESM 100); or equivalent.

Learning Activities: Lecture/Lab 3 hour(s), Fieldwork.

Cross Listing: EBS 147.

Grade Mode: Letter.

General Education: Science & Engineering (SE).

HYD 150 – Water Law (3 units)

Course Description: Principles and issues of California Water Law. Types of water rights, groundwater rights and management, and protection of instream uses. Water projects, role of federal government and federal/state relations. Basic water quality acts, endangered species act, water transfers and current water issues.

Prerequisite(s): Consent of instructor or upper division standing.

Learning Activities: Lecture 3 hour(s).

Grade Mode: Letter.

General Education: Social Sciences (SS); American Cultures, Governance, & History (ACGH).

HYD 151 – Field Methods in Hydrology (4 units)

Course Description: Measurement methods and data analysis for evaluation of water storage, movement and contamination in the field. Equipment such as data loggers, water and sediment samplers, pressure transducers, weather stations, surveying equipment, and flow meters will be used.

Prerequisite(s): ERS 100 or HYD 141.

Learning Activities: Lecture 2 hour(s), Laboratory 3 hour(s), Fieldwork 3 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL).

HYD 182 – Environmental Analysis using GIS (4 units)

Course Description: Ecosystem and landscape modeling with emphasis on hydrology and solute transport. Spatial analysis of environmental risk analysis including ecological risk assessment, natural resource management. Spatial database structures, scripting, data models, and error analysis in GIS.

Prerequisite(s): ABT 150 or LDA 150; or equivalent GIS experience and skills; general biology and/or ecology courses are recommended.

Learning Activities: Lecture 2 hour(s), Laboratory 4 hour(s).

Cross Listing: ABT 182.

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL).

HYD 192 – Hydrologic Science Internship (1-12 units)

Course Description: Work experience off and on campus in water science. Internship supervised by a member of the faculty.

Prerequisite(s): Consent of instructor; completion of 84 units.

Learning Activities: Internship 3-40 hour(s).

Grade Mode: Pass/No Pass only.

HYD 198 – Directed Group Study (1-5 units)

Course Description: Directed group study. May be taught abroad.

Learning Activities: Variable.

Grade Mode: Pass/No Pass only.

HYD 199 – Special Study for Advanced Undergraduate (1-5 units)

Course Description: Special study for advanced undergraduates.

Prerequisite(s): Senior standing.

Learning Activities: Variable.

Grade Mode: Pass/No Pass only.

HYD 201A – Hydrologic Sciences Core Survey (3 units)

Course Description: Considers the primary sub-disciplines while reviewing the fundamental scientific concepts/processes of the hydrologic sciences research community, and includes a basic writing component.

Learning Activities: Lecture/Discussion 2 hour(s), Project.

Grade Mode: Letter.

HYD 201B – Hydrologic Sciences Core Seminar (1 unit)

Course Description: Exposes students to the research underway in the Hydrologic Sciences Graduate Group as well as provide them the opportunity to present and refine their research through interaction with other students in the Graduate Group.

Learning Activities: Seminar 2 hour(s).

Repeat Credit: May be repeated 2 time(s).

Grade Mode: Pass/No Pass only.

HYD 210 – Vadose Modeling & Characterization (3 units)

Course Description: Principles and modeling of water flow and chemical transport in the vadose zone, with specific applications to soils. Topics include hydraulic properties, finite difference application to unsaturated water flow, parameter optimization, diffusive and convective transport in gaseous and liquid phases.

Prerequisite(s): SSC 107; or consent of instructor.

Learning Activities: Lecture 1.50 hour(s), Laboratory 3 hour(s), Discussion 0.50 hour(s).

Grade Mode: Letter.

HYD 241 – Precision Irrigation Systems & Management (3 units)

Course Description: Advanced irrigation science and engineering for agricultural, horticultural, engineering, and hydrology graduate students. Precision irrigation techniques for application of water to meet specific requirements of individual plants or management units and maximum economic benefits of crop production.

Prerequisite(s): ABT 110; SSC 100; HYD 110; EBS 145.

Learning Activities: Lecture 3 hour(s).

Cross Listing: EBS 241.

Grade Mode: Letter.

HYD 242 – Hydrology & Sustainability of Irrigated Lands (3 units)

Course Description: Impact of irrigated agricultural on groundwater depletion, surface water and groundwater quality, soil salinization, downstream ecosystems, and seawater intrusion. Exploration of efficient resource use, and policies adopted in California to enhance sustainability of irrigated crop production.

Prerequisite(s): ABT 110 or ESM 110 or HYD 110 or EBS 145.

Learning Activities: Lecture 3 hour(s).

Cross Listing: EBS 242.

Grade Mode: Letter.

HYD 243 – Water Resource Planning & Management (3 units)

Course Description: Applications of deterministic and stochastic mathematical programming techniques to water resource planning, analysis, design and management. Water allocation, capacity expansion, and reservoir operation. Conjunctive use of surface water and groundwater. Water quality management. Irrigation planning and operation models.

Prerequisite(s): HYD 141 or ECI 142.

Learning Activities: Lecture 3 hour(s).

Cross Listing: EBS 243.

Grade Mode: Letter.

HYD 245 – Climate Change, Water & Society (4 units)

Course Description: Integration of climate science and hydrology with policy to understand hydroclimatology and its impact upon natural and human systems. Assignments: readings, take-home examination on climate and hydrologic science, paper that integrates course concepts into a research prospectus or review article.

Learning Activities: Lecture 4 hour(s).

Enrollment Restriction(s): Limited to 25 students.

Cross Listing: ATM 245, ECL 245.

Grade Mode: Letter.

HYD 252 – Hillslope Geomorphology & Sediment Budgets (4 units)

Course Description: Exploration of theoretical and empirical foundations of sediment production on hillslopes using computer models and field experiments to promote an understanding of how watersheds evolve naturally and with human impacts.

Prerequisite(s): HYD 141 or GEL 035 or ECI 142; or consent of instructor.

Learning Activities: Lecture 3 hour(s), Fieldwork 3 hour(s).

Grade Mode: Letter.

HYD 254Y – Ecohydraulics (3 units)

Course Description: Use of 2D hydrodynamic modeling to perform instream flow assessment by exploring flow-dependent hydraulic patterns at multiple spatial scales and extrapolating results with empirical and analytical functions to evaluate geomorphic resilience and ecological functions.

Learning Activities: Web Virtual Lecture 1 hour(s), Discussion 1 hour(s), Extensive Problem Solving.

Grade Mode: Letter.

HYD 256 – Geomorphology of Estuaries & Deltas (4 units)

Course Description: Survey of the processes and landforms associated with sediment deposition in the coastal zone. Application of geomorphic principles to coastal management issues.

Prerequisite(s): HYD 141 or GEL 035; or ECI 042 or consent of instructor.

Learning Activities: Lecture 3 hour(s), Fieldwork 3 hour(s).

Grade Mode: Letter.

HYD 264 – Modeling of Hydrologic Processes (3 units)

Course Description: Techniques used to model the spatio-temporal structure of rainfall and runoff are introduced. Procedures studied include those based on stochastic point processes, chaos theory, fractal geometry, and fractional noises.

Prerequisite(s): HYD 141; STA 102; or the equivalents.

Learning Activities: Lecture 3 hour(s).

Grade Mode: Letter.

HYD 269 – Numerical Modeling of Groundwater Systems (3 units)

Course Description: Finite difference and finite element techniques in modeling groundwater flow and transport. Fundamentals of constructing and calibrating models with hands-on applications. Methods and limitations of numerical solution of transport equations. Model interpretation and ethics.

Prerequisite(s): MAT 022B; (ECI 144; or HYD 145A); HYD 145B.

Learning Activities: Lecture 3 hour(s).

Grade Mode: Letter.

HYD 273 – Introduction to Geostatistics (4 units)

Course Description: Statistical treatment of spatial data with hydrologic emphasis. Topics: theory of random functions, variogram analysis, Kriging/co-Kriging, indicator geostatistics, and stochastic simulation of spatial variability. Geostatistical software use.

Prerequisite(s): STA 130A; STA 130B; or the equivalent.

Learning Activities: Lecture 3 hour(s), Discussion 1 hour(s).

Grade Mode: Letter.

HYD 274 – Practice of Groundwater Flow & Transport Modeling (3 units)

Course Description: Selecting and building groundwater flow and transport models. Planning, preparation, execution, presentation, and review of modeling projects. Review of methods, assumptions, and limitations of groundwater models; practicing with MODFLOW, MT3D, associated GUI, and with other groundwater modeling software of choice.

Learning Activities: Lecture 2 hour(s), Lecture/Lab 0.50 hour(s), Lecture/Discussion 0.50 hour(s).

Grade Mode: Letter.

HYD 275 – Analysis of Spatial Processes (3 units)

Course Description: Characterization of homogeneous random fields; extremes and spectral parameters; geometry of excursions, local averaging; scale of fluctuation; non-Gaussian and irregular random fields; geostatistical applications.

Prerequisite(s): STA 102; or the equivalent; HYD 273 or STA 273A recommended.

Learning Activities: Lecture 3 hour(s).

Grade Mode: Letter.

HYD 286 – Selected Topics in Environmental Remote Sensing (3 units)

Course Description: In depth investigation of advanced topics in remote sensing applications, measurements, and theory.

Prerequisite(s): ERS 186; consent of instructor, or equivalent; ERS 186L recommended.

Learning Activities: Discussion 2 hour(s), Lecture 1 hour(s), Project.

Repeat Credit: May be repeated.

Cross Listing: GEO 286.

Grade Mode: Letter.

HYD 290 – Seminar in Hydrologic Science (1 unit)

Course Description: Seminars and critical review of problems, issues, and research in hydrologic sciences. Oral presentations of research. Topics vary.

Prerequisite(s): Consent of instructor. Graduate standing and background in Hydrologic Science.

Learning Activities: Seminar 1 hour(s).

Repeat Credit: May be repeated.

Grade Mode: Satisfactory/Unsatisfactory only.

HYD 298 – Group Study (1-5 units)

Course Description: Group study.

Prerequisite(s): Consent of instructor; graduate standing.

Learning Activities: Variable.

Grade Mode: Satisfactory/Unsatisfactory only.

HYD 299 – Research (1-12 units)

Course Description: Research.

Prerequisite(s): Consent of instructor. Graduate standing.

Learning Activities: Variable.

Grade Mode: Satisfactory/Unsatisfactory only.

HYD 396 – Teaching Assistant Training Practicum (1-4 units)

Course Description: Teaching assistant training.

Learning Activities: Variable.

Repeat Credit: May be repeated.

Grade Mode: Pass/No Pass only.

HYD 440 – Hazardous Waste Operations Training (3 units)

Course Description: Forty-hour course designed to meet the requirements of Federal OSHA regulation CFR 1910.120. Covers the health, regulatory, processing and safe handling issues/problems associated with working with hazardous materials.

Prerequisite(s): Upper division standing in College of Agricultural and Environmental Sciences.

Learning Activities: Lecture 2 hour(s), Laboratory 2 hour(s).

Grade Mode: Pass/No Pass only.

Sustainable Agriculture & Food Systems (SAF)**SAF 090 – SA & FS Seminar (1-2 units)**

Course Description: Introductory or survey topics within Sustainable Agriculture & Food Systems.

Learning Activities: Seminar 1-3 hour(s).

Repeat Credit: May be repeated when topic differs.

Grade Mode: Pass/No Pass only.

SAF 090X – SA & FS Portfolio (1-4 units)

Course Description: SA&FS Portfolios are designed to complement interdisciplinary, academic coursework by supporting student development of each of the SA&FS Student Learning Outcomes: Systems Thinking, Experimentation & Inquiry, Understanding Values, Interpersonal Communication, Strategic Management, Civic Engagement and Personal Development.

Prerequisite(s): Consent of instructor.

Learning Activities: Workshop 3-12 hour(s).

Enrollment Restriction(s): Restricted to Sustainable Agriculture & Food Systems majors with lower-division standing or consent of instructor.

Repeat Credit: May be repeated.

Grade Mode: Pass/No Pass only.

SAF 092 – Internship (1-12 units)

Course Description: Lower-division internship for students enrolled in the Sustainable Agriculture & Food Systems program of study.

Prerequisite(s): Consent of instructor.

Learning Activities: Internship 3-36 hour(s), Variable 1 hour(s).

Enrollment Restriction(s): Restricted to Sustainable Agriculture & Food Systems majors or with consent of instructor; non-majors by consent of instructor.

Repeat Credit: May be repeated 12 unit(s).

Grade Mode: Pass/No Pass only.

SAF 098 – Directed Group Study (1-5 units)

Course Description: Group study on focused topics in Sustainable Agriculture & Food Systems. Varies according to instructor. Course plan is adapted to student need and interest in conjunction with the expertise of the instructor.

Prerequisite(s): Consent of instructor.

Learning Activities: Variable 3-15 hour(s).

Enrollment Restriction(s): Restricted to Sustainable Agriculture & Food Systems major or with consent of instructor.

Repeat Credit: May be repeated.

Grade Mode: Pass/No Pass only.

SAF 099 – Special Study for Undergraduates (1-5 units)

Course Description: Under faculty supervision, students pursue a special or individualized course of study related to Sustainable Agriculture & Food Systems.

Prerequisite(s): Consent of instructor.

Learning Activities: Independent Study 3-15 hour(s).

Repeat Credit: May be repeated.

Grade Mode: Pass/No Pass only.

SAF 165 – Irrigation Practices for an Urban Environment (3 units)

Course Description: Basic design, installation, and operation principles of irrigation systems for turf and landscape: golf courses, parks, highways, public buildings, etc. Emphasis on hardware association with sprinkler and drip/trickle systems.

Prerequisite(s): PHY 001A.

Learning Activities: Lecture/Discussion 2 hour(s), Project.

Cross Listing: ABT 165.

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Visual Literacy (VL).

SAF 192 – Internship (1-12 units)

Course Description: Upper-division internship for students enrolled in the Sustainable Agriculture & Food Systems program of study.

Prerequisite(s): Consent of instructor; upper division standing.

Learning Activities: Internship 3-36 hour(s), Variable 1 hour(s).

Enrollment Restriction(s): Restricted to Sustainable Agriculture & Food Systems majors or non-majors by consent of instructor.

Repeat Credit: May be repeated 12 unit(s).

Grade Mode: Pass/No Pass only.

SAF 197T – Tutoring in Sustainable Agriculture & Food Systems (1-5 units)

Course Description: Undergraduates assist the instructor by tutoring students in regularly scheduled courses that fulfill SA&FS major requirements.

Prerequisite(s): Consent of instructor; upper division standing.

Learning Activities: Tutorial 3-15 hour(s).

Repeat Credit: May be repeated.

Grade Mode: Pass/No Pass only.

SAF 197TC – SA&FS Tutoring in the Community (1-5 units)

Course Description: Undergraduates assist the instructor by tutoring in the community in settings related to Sustainable Agriculture & Food Systems.

Prerequisite(s): Consent of instructor; upper division standing.

Learning Activities: Tutorial 3-15 hour(s).

Repeat Credit: May be repeated.

Grade Mode: Pass/No Pass only.

SAF 198 – Directed Group Study (1-5 units)

Course Description: Group study on focused topics in Sustainable Agriculture & Food Systems. Varies according to instructor. Course plan is adapted to student need and interest in conjunction with the expertise of the instructor.

Prerequisite(s): Consent of instructor; upper division standing.

Learning Activities: Variable 3-15 hour(s).

Enrollment Restriction(s): Restricted to Sustainable Agriculture & Food Systems major or with consent of instructor.

Repeat Credit: May be repeated.

Grade Mode: Pass/No Pass only.

SAF 199 – Special Study for Advanced Undergraduates (1-5 units)

Course Description: Under faculty supervision, advanced students pursue a special or individualized course of study related to Sustainable Agriculture & Food Systems.

Prerequisite(s): Consent of instructor; upper division standing.

Learning Activities: Independent Study 3-15 hour(s).

Repeat Credit: May be repeated.

Grade Mode: Pass/No Pass only.

Soil Science (SSC)

SSC 010 – Soils in Our Environment (3 units)

Course Description: Soils in our global ecosystem; soils as natural bodies formed by interactive environmental processes; soil response to use and management; sustainable use of soil resources; role of soils in agricultural and environmental issues; role of soils in our daily lives.

Learning Activities: Lecture 3 hour(s), Independent Study.

Enrollment Restriction(s): Limited to 90 students.

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL).

SSC 092 – Soil Science Internship (1-12 units)

Course Description: Work experience off and on campus in soil science. Internship supervised by a member of the faculty.

Prerequisite(s): Consent of instructor; lower division standing.

Learning Activities: Internship 3-36 hour(s).

Grade Mode: Pass/No Pass only.

SSC 100 – Principles of Soil Science (5 units)

Course Description: Soil as part of natural and managed ecosystems and landscapes. Solid, liquid, and gas phases and their interactions in the soil. Water, gas and heat movement in soil. Soil biology. Plant nutrient acquisition and use. Soil development, management and use.

Prerequisite(s): College-level courses in each of chemistry, physics, biology, and geology recommended.

Learning Activities: Lecture 3 hour(s), Laboratory 3 hour(s), Term Paper.

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL).

SSC 102 – Environmental Soil Chemistry (3 units)

Course Description: Soil chemistry processes related to the fate and transport of contaminants in soil. Soil minerals, natural organic matter, surface charge, soil solution chemistry, redox reactions in soil, and sorption of inorganic and organic contaminants.

Prerequisite(s): General chemistry; SSC 100 or equivalent recommended.

Learning Activities: Lecture 3 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL).

SSC 105 – Field Studies of Soils in California Ecosystems (5 units)

Course Description: Field-based studies of soils in California ecosystems, away from campus, throughout California. Emphasis on description and classification of soils; relationships among soils, vegetation, geology, and climate; physical, chemical, and biological processes in soils on the landscape; and the role of soils in land use.

Prerequisite(s): SSC 100 and SSC 120 or equivalent recommended.

Learning Activities: .

Enrollment Restriction(s): Limited to a minimum of 10 students; maximum of 24.

Repeat Credit: May be repeated 1 time(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL); Writing Experience (WE).

SSC 107 – Soil Physics (5 units)

Course Description: Physical properties of soil. Principles of water, gas, heat, and solute movement in soil with selected examples related to soil and water management. Influence of soil properties on transfer processes.

Prerequisite(s): SSC 100; ERS 100; MAT 016A; or the equivalent of MAT 016A.

Learning Activities: Lecture 3 hour(s), Laboratory 3 hour(s), Discussion 1 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE).

SSC 109 – Sustainable Nutrient Management (4 units)

Course Description: Availability of nutrients in organic and conventional agricultural, vineyard, orchard and plantation forest soils; management of fertilizers, cover crops, compost, sewage sludge and manures for crop production and to prevent loss to the environment is emphasized.

Prerequisite(s): SSC 100; or the equivalent.

Learning Activities: Lecture 3 hour(s), Laboratory 3 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Oral Skills (OL); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL); Writing Experience (WE).

SSC 111 – Soil Microbiology (4 units)

Course Description: Major groups of microorganisms in soil, their interrelationships, and their responses to environmental variables. Role of microorganisms in cycling of nutrients. Plant-microbe relationships. Transformations of organic and inorganic pollutants.

Prerequisite(s): BIS 002C recommended.

Learning Activities: Lecture 3 hour(s), Laboratory 3 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Writing Experience (WE).

SSC 112 – Soil Ecology (3 units)

Course Description: Overview of living constituents of soils, their interactions, importance to, and impact on biogeochemical cycles, decomposition, and soil properties. Practical applications of soil biological diversity are emphasized.

Prerequisite(s): SSC 100 or equivalent recommended.

Learning Activities: Lecture 2 hour(s), Discussion 1 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE).

SSC 118 – Soils in Land Use & the Environment (4 units)

Course Description: Soils are considered as elements in land use planning and environmental quality. Topics include: soil survey reports, remote sensing, land capability classification, soil erosion/conservation, waste disposal on soils and soil reclamation. One one-day field trip.

Prerequisite(s): Consent of instructor; SSC 100 or equivalent recommended.

Learning Activities: Lecture 3 hour(s), Discussion 1 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Scientific Literacy (SL).

SSC 120 – Soil Genesis, Morphology, & Classification (5 units)

Course Description: Recognition and description of soils; chemical, biological and physical processes of soil formation. Factors of soil formation. Interactions of soils with diverse ecosystems. Introduction to soil classification. Practice using soil taxonomy. Practical experience describing soil properties in the field.

Prerequisite(s): SSC 100; GEL 050 recommended.

Learning Activities: Lecture 4 hour(s), Laboratory 3 hour(s).

Grade Mode: Letter.

General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL).

SSC 192 – Soil Science Internship (1-12 units)

Course Description: Work experience off and on campus in soil science. Internship supervised by a member of the faculty.

Prerequisite(s): Consent of instructor; completion of 84 units.

Learning Activities: Internship 3-36 hour(s).

Grade Mode: Pass/No Pass only.

SSC 198 – Directed Group Study (1-5 units)

Course Description: Directed group study.

Prerequisite(s): Consent of instructor.

Learning Activities: Variable.

Grade Mode: Pass/No Pass only.

SSC 199 – Special Study for Advanced Undergraduates (1-5 units)

Course Description: Special study for advanced undergraduates.

Prerequisite(s): Consent of instructor.

Learning Activities: Variable.

Grade Mode: Pass/No Pass only.

SSC 202 – Topics in Advanced Soil Chemistry (4 units)

Course Description: Reviews of current research in soil chemistry. Topics include double layer theory; clay mineral and oxide surface chemistry; adsorption on soil surfaces; speciation and modeling of solution ions; solubility and mineral stability diagrams.

Prerequisite(s): Consent of instructor; general chemistry; SSC 100 or equivalent recommended.

Learning Activities: Lecture 3 hour(s), Discussion 1 hour(s).

Enrollment Restriction(s): Restricted to 18 students.

Repeat Credit: May be repeated 1 time(s) when topic differs.

Grade Mode: Letter.

SSC 205 – Field Studies of Soils in California Ecosystems (5 units)

Course Description: Field-based soil studies in California ecosystems.

Description and classification of soils; relationships among soils, vegetation, geology, and climate; physical, chemical, and biological processes; their role in land use. Similar to SSC 105; requires additional work for graduate credit.

Prerequisite(s): SSC 100 and SSC 120 or equivalent recommended.

Learning Activities: Fieldwork 50 hour(s), Discussion 15 hour(s), Lecture 5 hour(s).

Enrollment Restriction(s): Limited to 24 students.

Repeat Credit: May be repeated 1 time(s) when geographic locale differs.

Grade Mode: Letter.

SSC 208 – Soil-Plant Interrelationships (3 units)

Course Description: Plant needs, occurrence and reactions of water and mineral nutrients in soils; root systems and their growth in soils; mass flow and diffusion mechanisms in nutrient acquisition; models relating nutrient uptake to soil and plant characteristics; nutrient assimilation and crop quality.

Prerequisite(s): SSC 100; PLB 111; or consent of instructor.

Learning Activities: Lecture 3 hour(s).

Grade Mode: Letter.

SSC 211 – Advanced Soil Microbiology (3 units)

Course Description: Microbial metabolism of organic chemicals in soil, both natural and xenobiotic. Decomposition of organic matter. Kinetics of microbial processes in soil.

Prerequisite(s): CHE 008A; CHE 008B; SSC 111; BIS 102, BIS 103 or an equivalent course recommended.

Learning Activities: Lecture 3 hour(s).

Grade Mode: Letter.

SSC 219 – Ecosystem Biogeochemistry (4 units)

Course Description: Multidisciplinary analysis of energy and nutrient transfers within terrestrial ecosystems. Examination of processes and inter- and intra-system interactions between the atmosphere, biosphere, lithosphere and hydrosphere. Laboratory section uses biogeochemical simulation models to examine case studies.

Prerequisite(s): Introductory courses in ecology/biology and soils recommended; undergraduates accepted with consent of instructor.

Learning Activities: Lecture 3 hour(s), Discussion/Laboratory 2 hour(s).

Cross Listing: ECL 219.

Grade Mode: Letter.

SSC 220 – Pedology (3 units)

Course Description: Topics selected from studies of soil-forming processes, soil-geomorphic relations, mineral weathering, new developments in soil classification, and development of pedologic theory. Topics vary from year to year.

Prerequisite(s): Consent of instructor; SSC 120 recommended.

Learning Activities: Lecture 3 hour(s).

Repeat Credit: May be repeated 1 time(s).

Grade Mode: Letter.

SSC 222 – Global Carbon Cycle (3 units)

Course Description: Global carbon cycle from Phanerozoic epoch to modern times. Examination of long and short-term carbon cycles. Transfer of carbon among ocean, land and life with emphasis on humic substance formation, methods of characterization, reactions with organics and soil carbon stabilization.

Prerequisite(s): CHE 008A; CHE 008B; MAT 016A; MAT 016B; SSC 100; or the equivalent of SSC 100.

Learning Activities: Lecture 3 hour(s).

Grade Mode: Letter.

SSC 290 – Special Topics in Soil Science (1-4 units)

Course Description: Seminars and critical review of problems, issues, and research in soil science.

Prerequisite(s): Graduate standing.

Learning Activities: Seminar 1-4 hour(s), Variable.

Repeat Credit: May be repeated.

Grade Mode: Satisfactory/Unsatisfactory only.

SSC 298 – Group Study (1-5 units)

Course Description: Group study.

Prerequisite(s): Consent of instructor.

Learning Activities: Variable 1-5 hour(s).

Repeat Credit: May be repeated when topic differs.

Grade Mode: Satisfactory/Unsatisfactory only.

SSC 299 – Research (1-12 units)

Course Description: Research.

Prerequisite(s): Consent of instructor.

Learning Activities: Variable.

Grade Mode: Satisfactory/Unsatisfactory only.

SSC 396 – Teaching Assistant Training Practicum (1-4 units)

Course Description: Teaching assistant training practicum.

Prerequisite(s): Graduate standing.

Learning Activities: Variable.

Repeat Credit: May be repeated.

Grade Mode: Pass/No Pass only.