

# HYDROLOGIC SCIENCE (HYD)

## College of Agricultural & Environmental Sciences

### 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 (5 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 3 hour(s), Laboratory 3 hour(s), Discussion 1 hour(s).

*Grade Mode:* Letter.

### 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 019A (can be concurrent) or MAT 021A (can be concurrent) or MAT 016B (can be concurrent); or consent of instructor.

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

*Cross Listing:* EBS 144.

*Grade Mode:* Letter.

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

**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.

*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 Science & Impacts (4 units)**

*Course Description:* Overview of climate change science with a focus on climate change communication. Impacts of climate change on water, agriculture, energy, health, infrastructure, ecosystem services, tribal and indigenous communities. Climate justice, political, societal, and economic dimensions of these issues.

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

*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 285Y – Global Groundwater-Agriculture Nexus (4 units)**

*Course Description:* Sustainably managing groundwater in agricultural regions for global food security and human health; global geography of agriculture and groundwater; groundwater flow in ag regions; agricultural groundwater management and water law; groundwater quality issues in agricultural regions (nitrate, emerging contaminants); assessment of groundwater non-point source pollution; groundwater-environment-food nexus (to surface water, groundwater-dependent ecosystems); policy, compliance, and monitoring.

*Learning Activities:* Discussion 1 hour(s), Web Virtual 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.