

Soils 405/Geosc 405 **HYDROPEDOLOGY**

Fall 2012, 3 Credits

Instructor: Dr. Henry Lin
Office: ASI 444. Email: henrylin@psu.edu. Phone: 865-6726. Fax: 863-7043.

Class: Lec: T R 1:25 - 2:15 PM (ASI 205)
Lab: W 1:25 - 4:25 PM (various locations for field trips, ASI 463 for labs)

Office Hours: T R 2:30-3:30 pm, or by appointment.

Synopsis: Hydropedology takes a systems approach and holistic view to study interactive pedologic (soil) and hydrologic (water) processes and properties in the near-surface terrestrial environment (called the Earth's Critical Zone). Soil and water interaction creates the fundamental interface between the biotic and abiotic worlds, and is a key determinant of the state of the Earth system. Hydropedology aims to understand pedologic controls on hydrologic processes and properties, and hydrologic impacts on soil formation, variability, and functions. This class emphasizes real-world soils in the landscape where distinct pedogenic features (such as soil structure, horizonation, and heterogeneity), environmental variables (such as climate, landforms, and organisms), and anthropogenic impacts (such as land use and management) interact and dictate the landscape hydrologic and biogeochemical fluxes. The course will promote *active learning*, *critical thinking*, and *hands-on skills*. Ten (10) core messages (key principles) will be focused on, which each student will master by the end of the course and be able to apply to the real-world soils in the landscape.

Prerequisites: Introductory soil and water sciences (introductory courses in pedology, soil physics, and hydrology are helpful, but not required), plus college-level math and physics.

Text: Lin, H.S. 2012. *Hydropedology: Architecture and Function of Complex Geoderma*. (To be distributed through PSU ANGEL <https://cms.psu.edu/default.asp> and in class handouts).

References: Lin, H.S. (ed.) 2012. *Hydropedology – Synergistic Integration of Soil Science and Hydrology*. Elsevier.
Lin, H.S. et al. 2005. *Advances in hydropedology*. Adv. in Agronomy 85:1-89. Downloadable at <http://cropsoil.psu.edu/people/faculty/lin/advances2005.pdf>
Schaetzl, R. J., and S. Anderson. 2005. *Soils: Genesis and Geomorphology*. Cambridge.
Buol, S. et al. 2001. *Soil Genesis and Classification*. 5th edition. Iowa State Press.
Hillel, D.J. 1998. *Environmental Soil Physics*. Academic Press, NY.
Tindall, J.A., and J.R. Kunkel. 1999. *Unsaturated Zone Hydrology for Scientists and Engineers*. Prentice Hall

Grading: Grades will be based on 100% as distributed below. Breaks between letter grades will be at 90% (A), 80% (B), 70% (C), and 60% (D), with plus and minus grades as appropriate (A: 94-100, A-: 90-93, B+: 86-89, B: 83-85, B-: 80-82, C+: 76-79, C: 73-75, C-: 70-72, D+: 65-69, D: 60-64, F: <60). Final grades may be adjusted based on overall class performance.

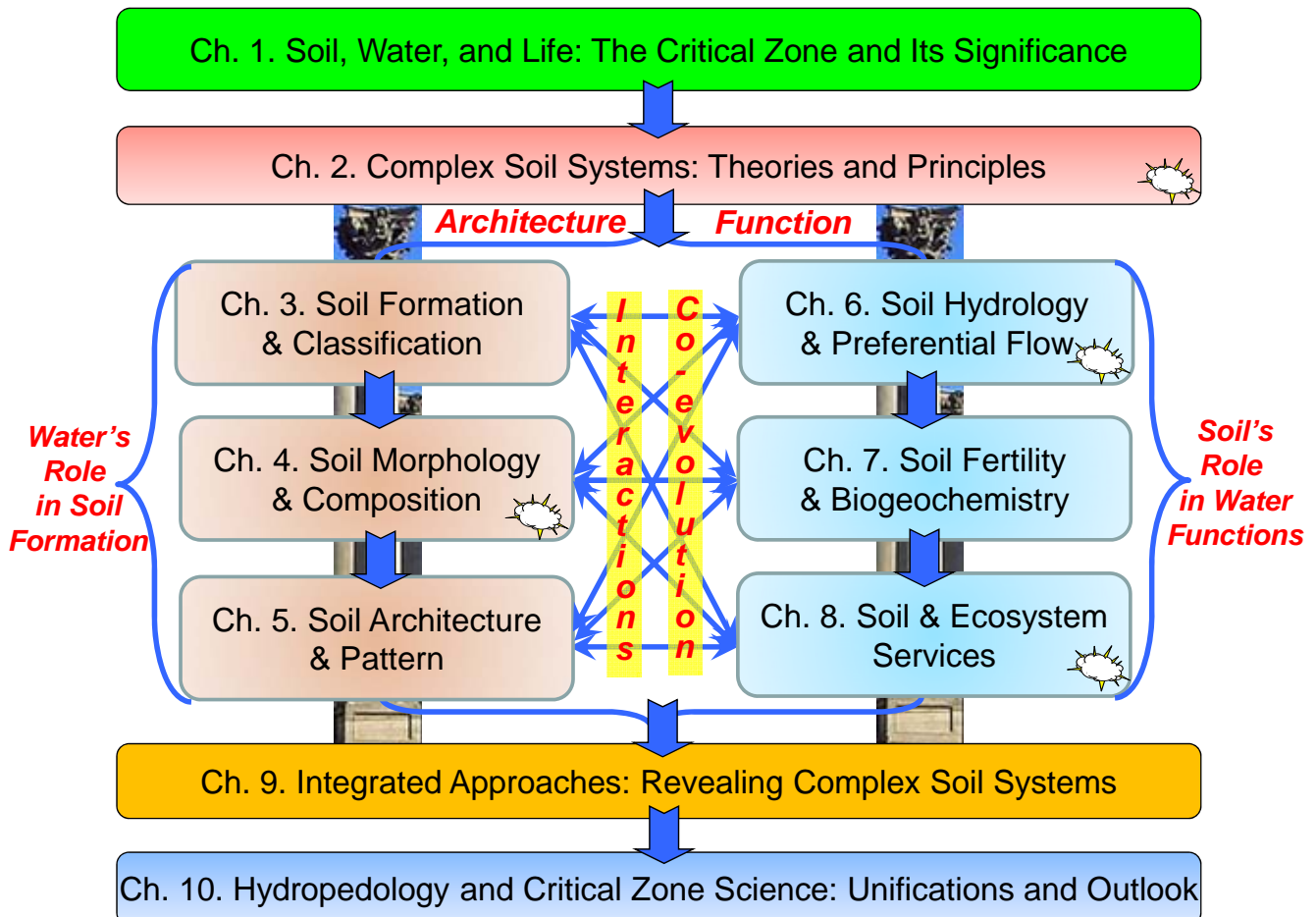
• Attendance & class discussions	10%
• Field trip or lab reports	35%
• Homework	35%
• Two exams (midterm and final)	20%
TOTAL	<u>100%</u>

Explanations of the above requirements and relevant guidelines will be provided in the 1st class. *Opportunities for bonus credit may arise from time to time during the semester.*

Attendance: **Regular attendance to lectures and labs is *required***. Students who have to miss a class **must** provide a legitimate reason beforehand and will be self-responsible for missed class.

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LECTURE OUTLINES



Notes:

- **Each student is expected to complete reading assignment *each week* and be prepared to *actively participate in classroom discussions*.** With limited time in each lecture, only ***highlights*** from the course materials will be provided in each lecture. Some class time will also be spent in various discussions and answering students' questions. Thus ***outside-classroom reading is essential to effective learning in this course.***
- **One key principle from each chapter will be expected for each student to learn and apply to related homework and field/lab exercise.**

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FIELD AND LABORATORY EXERCISES

Week 1 (8/29): **Field Trip**: Soil Profile Description + Landscape Reading & Web Soil Survey

Week 2 (9/5): **Lab**: Soil Water Retention Curve: Soil Water Content + Water Potential

Week 3 (9/12): **Field Trip**: Shale Hills Watershed: Hydropedology + Landscape Hydrology

Week 4 (9/19): **Field Trip**: Penn State Living Filter: Wastewater Treatment + Disposal

Week 5 (9/26): **Field Trip**: Fox Hollow Watershed: Stormwater Management + Runoff

Week 6 (10/3): **Lab**: Soil Hydraulic Conductivity: Ksat and Bulk Density + kuPF & Infiltrimeters

Week 7 (10/10): **Field Trip**: Agronomy Farm: Catena Concept + Hillslope Hydrology

Week 8 (10/17): **Lecture catch-up and review for midterm exam**

Week 9 (10/24): **No Class** – *Self catch-up for midterm exam*

Week 10 (10/31): **Field Trip**: Geophysical Tools: Ground Penetrating Radar (GPR) + Electromagnetic Induction (EMI)

Week 11 (11/7): **Field Trip**: Kepler Farm: Hydropedology + Precision Agriculture

Week 12 (11/14): **Field Trip**: Shale Hills Watershed: Hydropedology + Critical Zone Observatory

Week 13 (11/21): **No Classes** – *Thanksgiving Holiday*

Week 14 (11/28): **Lab**: Chemical Transport in Soils: Adsorption and Preferential Flow

Week 15 (12/5): **No Class** – *Self review for final exam*

Week 16 (12/12): **Review for final**

Notes:

- **A field trip or lab report is due in the week following each exercise.** Reports are to be a brief summary of each student's personal experience and knowledge learned in each exercise through highlighting **3 main things learned** from each exercise (especially those related to class lectures and key principles emphasized), plus **answers to 3 questions** related to each exercise.
- Field trips would be weather dependent and the schedule may be adjusted if necessary.

Learning Resources Related to Hydropedology

Online databases and literature search:

- ISI Web of Science: Free access through PSU Library web site.
- Google Scholar: http://scholar.google.com/advanced_scholar_search?hl=en&lr=
- ScienceDirect: <http://www.sciencedirect.com/science>

Online books and resources:

- Soil Science Society of America (SSSA) Glossary of soil science terms: <http://www.soils.org/sssagloss/>
- Online USDA-NRCS books and standards: <http://soils.usda.gov/technical/>
- Online soil surveys of the U.S.: http://soils.usda.gov/survey/online_surveys/
- Online Official soil series description (OSD): <http://soils.usda.gov/technical/classification/osd/index.html>
- Keys to Soil Taxonomy: http://soils.usda.gov/technical/classification/tax_keys/
- National Research Council books (Read online free!): <http://books.nap.edu/>
- Free ebooks (Project Gutenberg Online Book Catalog): http://www.gutenberg.org/wiki/Main_Page
- Wikipedia – Free online encyclopedia: http://en.wikipedia.org/wiki/Main_Page

Popular soil and water scientific journals:

- Soil Science Society of America J.
- Soil Science
- Vadose Zone J.
- J. Environmental Quality
- Environmental Science & Technology
- J. Soil & Water Conservation
- Geoderma
- Catena
- Soil Tillage Research
- European J. Soil Science (J. Soil Science)
- Canadian J. Soil Science
- Australia J. Soil Res.
- Soil Science and Plant Analysis
- Hydrology and Earth System Sciences
- Water Resources Research
- J. of American Water Resources Association
- Water Research
- Hydrogeology
- J. Hydrology
- J. Contaminant Hydrology
- Transactions of ASABE
- Wetlands
- Ecological Modeling
- Ecology
- Geomorphology
- Land Degradation
- Geo. Soc. Am. Bull.
- Quaternary Research
- Global Change Biology
- J. Geophysical Research
- Biogeochemistry

Landscape-soil-hydrology selected references:

- Brady, N.C., and R.R. Weil. 2000. Elements of the nature and properties of soils. Prentice Hall.
- Hillel, D.J. 1991. Out of the earth - Civilization and the life of the soil. The free Press, NY.
- Jenny, H. 1941. Factors of Soil Formation--A System of Quantitative Pedology. McGraw-Hill.
- Richardson, J.L., and M.J. Vepraskas. 2001. Wetland soils: genesis, hydrology, landscapes, and classification. LEWIS, CRC Press, Boca Raton, FL.
- Kirkby, M.J. 1978. Hillslope Hydrology. Wiley.
- Drever, J.I. (Ed.). 2004. Surface and Ground Water, Weathering, and Soils. Elsevier.
- Leopold, L.B., M.G. Wolman, J.P. Miller. 1964. Fluvial processes in geomorphology. Freeman.
- Dane, J.H., and G.C. Topp (ed.) 2002. Methods of Soil Analysis. Part 4. Physical Methods. SSSA Book Ser. 5. Soil Science Society of America, Inc., Madison, WI.
- Soil Survey Staff. 1993. Soil Survey Manual. U.S. Dept. Agri. Handbook No. 18. U.S. Government Printing Office, Washington, DC.
- Soil Survey Staff. 1999. Soil Taxonomy – A Basic System of Soil Classification for Making and Interpreting Soil Surveys. 2nd edition. USDA-NRCS Agricultural Handbook No. 436.