CEE 6400 Physical Hydrology
Fall 2013

General Information

CEE 6400 Physical Hydrology
Mon, Wed, 1:30-2:50 pm, EL 221

Instructor

David Tarboton
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Office Hours in ENGR 230 on campus: Tues, Thur 1-2 pm. Also most days immediately following lecture. You may send me email any time to ask a question or request a meeting outside these times. You may also access my calendar online (http://www.google.com/calendar/embed?src=david.tarboton@gmail.com&ctz=America/Denver) to determine my availability.
Instructor web page: http://www.engineering.usu.edu/dtarb
Class web page: http://www.engineering.usu.edu/dtarb/cee6400/ (This will be updated regularly during the course)

Catalog Information

Fundamentals of hydrologic cycle and hydrologic processes. Precipitation, infiltration, runoff generation, evaporation and transpiration, and snowmelt. Representation of hydrologic processes in hydrologic models.
3 credits, Fall semester. Prerequisite Undergraduate Hydrology (CEE 3430) or equivalent.

Goal

To obtain an understanding and appreciation of hydrology as a quantitative science describing the occurrence, distribution and movement of water at and near the surface of the earth. Develop a sound intuitive and quantitative understanding of the physical processes involved in the land phase of the hydrologic cycle. Learn how to use this knowledge to address engineering problems. Gain exposure to research problems and issues involving the physical understanding and parameterization of hydrologic processes.

Learning Objectives

- To be able to retrieve hydrologic data and evaluate quantities that support quantitative interpretation and description of the associated hydrologic processes and phenomena (streamflow, precipitation, evaporation, infiltration, subsurface water).
- To be able to quantitatively describe and evaluate the processes involved in the hydrologic cycle.
- To be able to use key hydrologic principles, such as conservation of mass and energy, and other principles from physics in the quantification and modeling of hydrologic processes.
- To be able to apply and interpret the results from simple hydrologic models to examine questions and problems that hydrologists and water resource engineers may face.

Prerequisites

1. An undergraduate level understanding of hydrology from a course such as CEE3430 or equivalent.
2. Physics. An understanding of forces and the laws of motion as well as physical and thermal properties of matter (water, air, soil).
3. Mathematics. An understanding of calculus and algebra as the language of science and engineering used to express a quantitative understanding of physical phenomena
4. Computer literacy. An ability to use computers to process, analyze and plot data, using appropriate software (e.g. spreadsheets or programming language).

Topics:

1. Introduction, the hydrologic cycle, conservation laws, error assessment (Dingman, ch 1 and 2)
2. The climate system: radiation, energy balance, greenhouse effect, El Nino Southern Oscillation (ENSO). (Dingman, ch 3)
3. Meteorology of precipitation. (Dingman, ch 4 p94-105)
4. Precipitation data analysis, Measurement and area averaging, Intensity-duration-frequency curves, Probable maximum precipitation. (Dingman ch4, p105-165)
5. Physical factors in the generation of runoff (Tarboton, 2003 online module ch 1-3; Dingman, ch 6)
6. Water in soil (Tarboton, 2003 online module ch 4, Dingman, ch 6)
7. Infiltration (Tarboton, 2003 online module ch 5, Dingman ch 9)
8. Digital elevation models and GIS in Hydrology (Research papers).
9. TOPMODEL and the role of topography and variable contributing areas in runoff generation (Tarboton, 2003 online module ch 6; Beven et al., 1995).
10. Routing surface runoff to a basin outlet. Overland flow, channel routing, unit hydrographs and linear systems theory. (Dingman ch 9, Chow et al., ch 7 p213-223).
11. Hydrologic Modeling (Dingman 2.9)
12. Evaporation. Energy input from solar radiation. Evapotranspiration physics and models. (Dingman ch 7, Appendix E. Handbook of Hydrology Ch 4).
13. Snow and snowmelt processes (Dingman ch 5. Handbook of Snow, ch 9).

Text and readings

Assigned textbook:

Dingman, S. L., (2002), Physical Hydrology, 2nd Edition, Prentice Hall, 646 p.

Supplementary reading (other sources you may find useful and may be referred to):

Tarboton, D. G., (2003), Rainfall Runoff Processes, Online module and workbook prepared for the National Weather Service COMET outreach program, http://www.engineering.usu.edu/dtarb/rrp.html.

Beven, K., R. Lamb, P. Quinn, R. Romanowicz and J. Freer, (1995), "TOPMODEL," in Computer Models of Watershed Hydrology, Edited by V. P. Singh, Water Resources Publications, Highlands Ranch, Colorado, p.627-668.

Bras, R. L., (1990), Hydrology, An introduction to hydrologic science, Addison Wesley, Reading, MA, 643 p.

Brutsaert, W., (2005), Hydrology: An Introduction, Cambridge University Press, 618 p.

Chow, V. T., D. R. Maidment and L. W. Mays, (1988), Applied Hydrology, McGraw Hill, 572 p.
Dunne, T. and L. B. Leopold, (1978), Water in Environmental Planning, W H Freeman and Co, San Francisco, 818 p.
Loucks, D. P., E. van Beek, J. R. Stedinger, J. P. M. Dijkman and M. T. Villars, (2005), Water Resources Systems Planning and Management: An Introduction to Methods, Models and Applications, UNESCO, Paris, 676 p, http://hdl.handle.net/1813/2804
Maidment, D. R., ed. (1993), Handbook of Hydrology, McGraw Hill.
Gray, D. M. and D. H. Male, ed. (1981), Handbook of Snow, Principles, processes, management & use, Pergamon Press, 776 p.
National Research Council Committee on Opportunities in the Hydrologic Sciences (COHS), (1991), Opportunities in the Hydrologic Sciences, Editor, P. S. Eagleson, National Academy Press, Washington, D.C, http://www.nap.edu/catalog.php?record_id=1543.

Grading

1. Grades will be based on a weighted average of results as follows:
   Homework: 40%
   Midterm exam: 25%
   Final exam: 35%

2. Incomplete grades will not be given except under extenuating circumstances as allowed for by University policy. Incomplete grades will not be given for poor performance.

3. Make up exams will only be given in cases of severe personal hardship or illness.

4. Examinations will be a combination of a closed book portion testing knowledge of definitions and basic principles that I expect you to remember and an open book portion where reference to the text and other material will be necessary for solution of the problems.

Homework

There will be homework assignments due every 1 - 2 weeks. Homework up to 1 week late, or the time a solution set is provided, whichever is sooner, will be accepted with 20% grade deduction. There will be a 50% deduction for homework received more than 1 week late or after a solution set has been provided.

You should submit homework solutions as hard (paper) copies, neatly assembled and presented in an orderly fashion. Computer output (text, code or graphics) that is handed in does not need to be high print quality, but should be concise and carefully labeled (by hand if easiest). There must be explanatory text accompanying computer printouts or graphs. Hand in enough (**and only enough**) to document precisely and concisely what you have done and how you obtained your solutions. Graphical output is favored over reams of printed numbers.

Disabilities

Students with ADA-documented physical, sensory, emotional or medical impairments may be eligible for reasonable accommodations. Veterans may also be eligible for services. All accommodations are coordinated through the Disability Resource Center (DRC) in Room 101 of the University Inn, (435)797-2444 voice, (435)797-0740 TTY, or toll free at 1-800-259-2966. Please contact the DRC as early in the semester as possible. Alternate format materials (Braille, large print or digital) are available with advance notice.

If you are a veteran or have a disability that requires accommodation please contact the DRC using the contact information above, or the instructor so that the necessary arrangements can be made.

CEE 6400 Physical Hydrology Schedule **(SUBJECT TO CHANGE)**				
Date		Topic	Reading[1]	Due dates
26-Aug	Mon	Introduction and the Hydrologic Cycle. Conservation laws. Error assessment. Water supply reservoir sizing.	Ch 1-2.	
28-Aug	Wed	Streamflow temporal variability. Working with R.	Ch 2.6, 2.7 & 2.8	HW0
2-Sep	Mon	Labor Day - No Class		
4-Sep	Wed	Water supply reservoir sizing and storage - yield analysis	Loucks et al., 2005[2], chapter 11, pages 343-347	
9-Sep	Mon	The climate system: radiation, energy balance, greenhouse effect, El Nino Southern Oscillation (ENSO).	Ch 3.	HW1
11-Sep	Wed			
16-Sep	Mon	Meteorology of precipitation.	Ch 4. p94-105	
18-Sep	Wed	Precipitation data analysis, Measurement and area averaging, Climatology, Intensity-duration-frequency curves, Probable maximum precipitation.	Ch 4. p105-165.	
23-Sep	Mon	Physical factors in the generation of runoff.	Ch 6. Online module4 Ch 1-3	
25-Sep	Wed	Water in Soil	Ch 6. Online module4 Ch 4	
30-Sep	Mon			
2-Oct	Wed	Infiltration	Ch 9. Online module4 Ch 5.	
7-Oct	Mon			
9-Oct	Wed			
14-Oct	Mon	Review		
16-Oct	Wed	MIDTERM		
21-Oct	Mon	Digital elevation models and GIS in Hydrology		
23-Oct	Wed			
28-Oct	Mon	TOPMODEL and the role of topography and variable contributing areas in runoff generation.	Ch 9. Online module ch 6; Beven et al., 1995[7].	
30-Oct	Wed			
4-Nov	Mon	Routing surface runoff to a basin outlet. Overland flow, channel routing, unit hydrographs and linear systems theory.	Ch 9, Chow et al.[5], ch 7 p213-223	
6-Nov	Wed			
11-Nov	Mon	Hydrologic Modeling	Ch 2.9	
13-Nov	Wed			
18-Nov	Mon	Evaporation. Energy input from solar radiation. Evapotranspiration physics and models.	Ch 7. Handbook of Hydrology[6] ch 4.	
20-Nov	Wed			
25-Nov	Mon			
27-Nov	Wed	No class. Thanksgiving holiday.		
2-Dec	Mon	Snow and snowmelt processes	CH 5. Handbook of Snow[8] Ch 9.	
4-Dec	Wed			
9-Dec	Mon	1.30-3.20. Final Exam. Comprehensive. EL 221 (This is the final exam slot according to the USU Fall 2013 Final Exam Schedule for classes that meet M or W at 2 pm).		

1. Unless otherwise designated - Readings refer to the primary text: Dingman, S. L., (2002), Physical Hydrology, 2nd Edition, Prentice Hall, 646 p.
2. Loucks, D. P., E. van Beek, J. R. Stedinger, J. P. M. Dijkman and M. T. Villars, (2005), Water Resources Systems Planning and Management: An Introduction to Methods, Models and Applications, UNESCO, Paris, 676 p, http://hdl.handle.net/1813/2804
3. Bras, R. L., (1990), Hydrology, An introduction to hydrologic science, Addison-Wesley, Reading, MA, 643 p.
4. Tarboton, D. G., (2003), Rainfall Runoff Processes, Online module and workbook prepared for the National Weather Service COMET outreach program, http://www.engineering.usu.edu/dtarb/rrp.html.
5. Chow, V. T., D. R. Maidment and L. W. Mays, (1988), Applied Hydrology, McGraw Hill, 572 p.
6. Shuttleworth, W. J., (1993), "Evaporation," in Handbook of Hydrology, Chapter 4, Edited by D. R. Maidment, McGraw-Hill, New York.
7. Beven, K., R. Lamb, P. Quinn, R. Romanowicz and J. Freer, (1995), "TOPMODEL," in Computer Models of Watershed Hydrology, Edited by V. P. Singh, Water Resources Publications, Highlands Ranch, Colorado, p.627-668.
8. Male, D. H. and D. M. Gray, (1981), "Snowcover Ablation and Runoff," in Handbook of Snow, Principles, Processes, Management and Use, Edited by D. M. Gray and D. H. Male, Pergammon Press, p.360-436.