ENE890: Advanced Hydrology (3 Credits)
Spring 2018

Instructor: Prof. Y. Pokhrel, Department of Civil & Environmental Engineering
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Class Meets: Tu, Th: 10:20 AM – 11:40 AM, Room 1202 Engineering Building
Office Hours: Tu : 1:30 PM – 2:30 PM, Room A134 ERC or by appointment

Textbook: There is no single textbook for all topics covered in this course. We will use Physical Hydrology by ***Lawrence S. Dingman***, Third Edition (ISBN-13: 978-1478611189) as the textbook, but I will use significant amount of materials from other books including:

- Hydrology by Wilfred Brutsaert, Cambridge University Press, 2005.
- Rainfall-Runoff Modeling - The Primer, Keith J. Beven.

Course Webpage: http://www.egr.msu.edu/classes/ene890/ypokhrel/
Username: _____; **Password**: _____ (provided in the first class)

Course Objectives: This course will cover advanced topics in hydrology with a focus on the concepts required for hydrological modeling over varying spatial (catchment to global) and temporal scales. The course will begin by providing an overview of the general concepts in physical hydrology, which are covered in undergraduate hydrology classes such as ENE 421. Then, we will move on to the advanced topics such as solving complex governing equations of energy and water balance at land and canopy surfaces; energy balance of snow and snowmelt; Richard's equation for vadose zone soil water movement; rainfall-runoff modeling using topographic index, TOPMODEL approach etc.; and solving Saint Venant equations for surface water flow using kinematic and diffusion wave equations and explicit and implicit methods. Other topics will include near-surface turbulent boundary layer processes and land-atmosphere interactions in relation to large-scale hydrological modeling, surface water-groundwater interactions in the context of increasing water exploitation, climate change, and sea level rise, use of remote sensing in hydrology, and human-water interactions. All topics will be discussed in relation to their relevance in hydrological modeling at varying spatial and temporal scales (with a particular emphasis on regional-global modeling using process-based LSMs).

Grading: The final grade will be based on: Homework/Quizzes/Participation (40%); Mid-term Exam (30%), Project Presentation (30%); there will be no final exam. The following grading scale will be used:

Score	Grade	Score	Grade
>= 90	4.0	70-74	2.0
86-90	3.5	65-69	1.5
80-85	3.0	55-64	1.0
75-80	2.5	00-54	0.0

Course Information & Student Responsibilities: We will try to follow the schedule provided in the first class but certain changes may be made during the semester to correct any errors or if we feel that we need more time on certain topic to go into additional details. Therefore, you should check the course web page regularly for the latest information. Course materials will be uploaded to the course webpage. You may also receive certain email notices from the instructor.

Assignment Rules: Due dates are not negotiable; late submissions **will be given a zero**. Feel free to discuss your homework/project with your fellow students. However, you are not allowed to copy or submit others' work as your own.

Academic honesty: Copying all, or part, of someone else's work, or project report, looking at someone else's quiz or exam during a test, or cheating in quizzes/exams are all obvious forms of academic dishonesty. Anyone found guilty of any form of academic dishonesty will not be excused and given a 0.0 for the entire course.

Tentative Schedule: The tentative schedule is provided in the table below. Some topics/dates are subject to revision at the discretion of the instructor; you will be notified of any changes.

	Day	Topic	Remarks
1	Jan 9 (Tu)	Introduction: Syllabus overview; Course Outline	
2	11 (Th)	The Hydrological Cycle: Global Water and Energy Budgets	
3	16 (Tu)	Why scale matters in hydrologic studies?	
4	18 (Th)	Precipitation: formation and processes (convective, stratiform)	
5	23 (Tu)	Precipitation: Data availability, spatio-temporal scale issues	
6	25 (Th)	Land surface energy balance: governing equations	
7	30 (Tu)	Solving energy balance at land and canopy surfaces	
8	Feb 1 (Th)	Project: Group formation, assignment, and discussion	
9	6 (Tu)	Evapotranspiration 1: general processes, components of ET, Turbulent boundary layer processes; aerodynamic resistance; stomatal control; canopy albedo	
10	8 (Th)	Evapotranspiration 2: surface turbulent fluxes; roughness for heat and momentum transfer; bulk coefficient with respect to vapor; moisture stress factor	
11	13 (Tu)	Evapotranspiration 3: Budyko curve; water vs. energy control on ET; micrometereological measurements	
12	15 (Th)	Evapotranspiration 4: retrieval from satellite data (MODIS)	
13	20 (Tu)	Rainfall-runoff modeling: TOPMODEL and SIMTOP	
14	22 (Th)	Rainfall-runoff modeling: Topographic control on runoff generation; DEM	
15	27 (Tu)	Vadose zone processes: Richard's equation - 1	
16	Mar 1 (Th)	Vadose zone processes: Richard's equation - 2	
-	6 (Tu)	No Class (Spring Break)	
-	8 (Th)	No Class (Spring Break)	
17	13 (Tu)	Review and Synthesis of topics covered so far	
18	15 (Th)	**Mid-term Exam** (Lecture 1 - 16); **Open Book; 1 cheat sheet (single sided); Calculator Required.**	Exam
19	20 (Tu)	Groundwater flow processes-1: General concepts and governing equations	
20	22 (Th)	Groundwater flow processes-1: regional groundwater aquifer; Analytical and Numerical solutions; simplification and application in large-scale hydrological modeling	
21	27 (Tu)	Streamflow routing-1: Saint Venant equations (kinematic wave, diffusion wave, and dynamic wave)	
22	29 (Th)	Streamflow routing-2: application over regional to global scales; upscaling DEM; deriving river width etc.	
23	Apr 3 (Tu)	Surface water-groundwater interactions over large scales: examples of the High Plains aquifer, and Amazon and Mekong river basins	
24	5 (Th)	Groundwater use and large-scale storage depletion: GRACE	
25	10 (Tu)	Land-atmosphere interactions, precipitation recycling, climate impacts of irrigation	
26	12 (Th)	Climate change and water resource sustainability	
27	17 (Tu)	Human-water-climate interactions	
28	19 (Th)	Relevance of topics covered in large-scale modeing	
29	24 (Tu)	Discussion on Project	
30	26 (Th)	Project Presentations	
-	4 (Th)	**Final Exam date (7:45 – 9:45 am) according to registrar's office.**	