Virginia Tech
The Charles E. Via Jr. Department of Civil and Environmental Engineering

CEE 4324: Open Channel Flow / CEE 5384: Advanced Open Channel Flow
(Spring 2018)

Description: This course covers the basic mechanics of open channel flow. Topics covered include: energy and momentum principles, uniform flow, gradually varied flow, channel transitions, and unsteady flow. In all cases, we will first examine the physics and resulting governing equations of the application of interest, and then look at solution methods and practical calculations. Those taking the graduate listing of the course will have an additional independent project they must complete.

Prerequisite: C- or better in CEE 3314

Instructor: Kyle Strom, Associate Professor
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Course Material

1. Required Book: *Fundamentals Of Open Channel Flow*, G. Moglen (2015).
2. Supplemental Material: Other "required" material will be handed out via Canvas.

Reference Material

Students are encouraged to learn from a variety of sources. Here are a few additional recommended books, journals, and movies.

1. Text Books
   (a) *Hydraulics of Open Channel Flow**, H. Chanson (2004), Elsevier/BH
   (b) *Open-Channel Flow**, H. Chaudhry (2008), Springer
   (c) *Open-Channel Hydraulics*, V. T. Chow (1959), McGraw-Hill
   (d) *Open Channel Flow*, F. Henderson (1966), Macmillan

*The library has the ebook with downloadable pdfs of chapters and/or the entire book.

   (e) *Open-Channel Flow*, S. Jain (2001), John Wiley & Sons
   (f) *Open Channel Hydraulics**, O. Akan (2006), Elsevier/BH
   (g) *Open Channel Hydraulics*, T. Sturm (2001/2010), McGraw-Hill
2. Journals
   (a) *Journal of Hydraulic Engineering*, American Society of Civil Engineers
   (b) *Journal of Hydraulic Research*, International Association of Hydraulic Research
   (c) *Advances in Water Resources*, Elsevier
3. Movies
   (a) NSF Sponsored series on fluid mechanics (playlist can be found here).
   (b) University of Iowa Hunter Rouse video series (playlist can be found here).
   (c) Other fluid mechanics playlist on the same YouTube channel.
   (d) The APS Division of Fluid Dynamics's Gallery of Fluid Motion.
4. Computation resources
   (a) A few links and examples to help you get going with Python
   (b) Introductory lectures on computing with python by Robert Johansson
   (c) HEC-RAS:
      - Main page
      - Examples

Course Topics

1. Introductory Topics
   (a) What are we after?
   (b) Introduction to Python and Jupyter notebooks
   (c) Definition of flow quantities and basic approach
   (d) Introduction to various flow states
2. Governing Conservation Equations
   (a) Mass
   (b) Energy
   (c) Momentum (Saint Venant)
3. Energy and Momentum Principles
   (a) Specific Energy
   (b) Critical Flow
   (c) The Specific Energy diagram
   (d) Momentum and the Specific Momentum diagram
   (e) Hydraulic jumps
4. Steady, Uniform Flow
   (a) Flow resistance
   (b) Normal depth calculations
5. Steady, Gradually Varied Flow (GVF)
   (a) A look back at the energy equation
   (b) Classification of channels and water surface profiles
   (c) Water surface profile calculations
6. Introduction to HEC-RAS
7. Unsteady Flow

(a) A look back at the Saint Venant Equations
(b) Introduction to numerical methods for open channel flows
(c) Channel routing and various approaches to solving the Saint Venant equations
(d) Dam break analysis

8. Hydraulic Structures (*If time permits*)
   (a) Weirs
   (b) Flumes
   (c) Culverts

Course Objectives:

1. Calculate the Froude number and understand its implications on flow, energy, and momentum.
2. Identify flow conditions that impose critical flow, conserve energy, and conserve momentum.
3. Employ graphical representations of energy and momentum to solve open channel flow transition problems.
4. Qualitatively and quantitatively determine gradually varied flow profiles.
5. Model unsteady flow in open channels.

Homework

Homework will be handed out through Canvas approximately every other week. Specific due dates for homework will be given along with the handout. Note that, at times, those taking the graduate section of the course will be given different, or additional, homework problems than those taking the undergraduate section.

Homework Requirements

1. Discussion of homework and collaboration with peers is encouraged. However, each student must submit their own **unique** work for credit. Anything deemed of "suspicious origins" will not be graded, and Honor Code violations will be addressed.
2. Homework submissions must be **legible** and **well organized**. Any illegible homework will not be graded. Homework solutions should be handwritten or printed on the front side of each piece of paper only (i.e., do not write on the front and back of a page). Please give an overview of the problem statement before presenting your work and solution. All final solutions should be boxed.

Project & Presentation (Graduate section only)

There is an additional team project and presentation associated with the graduate section of this course. Each project team will consist of 2 to 3 people. I will assign the teams and give each team a project in April. The projects could be laboratory based, analytical, or computational. Teams will carry out their experiments, simulations, or data analysis on their own timeline, and will then present their work in the form of a 15 min presentation (there is no written component to the project). We will schedule a block of time outside of normal lecture hours to allow for each team to present; we will develop a schedule that works for everyone as the time approaches. I will consider both the logic and quality of the work and presentation when assigning grades. All members of a given team will receive the same grade.

Exams

There will be one midterm exam and one final exam. Both exams will be closed book and closed notes. The first exam will be over Course Topics 1-4. The final exam will be comprehensive, but will be more heavily focused towards Course Topics 5 and 6. As of yet, a date for the midterm exam has not been set. **The final exam is scheduled for May 04, 2017 from 7:45 am to 9:45 am.**

Grading

Contributions Towards Final Grade	
Homework & Project	50%
Midterm Exam	20%
Final Exam	30%
Total	100%

Letter Grade	Overall Avg.	Letter Grade	Overall Avg.
A	94-100%	C	73-76%
A-	90-93%	C-	70-72%
B+	87-89%	D+	67-69%
B	83-86%	D	63-66%
B-	80-82%	D-	60-62%
C+	77-79%	F	<60%

Honor Code

The Undergraduate Honor Code pledge that each member of the university community agrees to abide by states: **"As a Hokie, I will conduct myself with honor and integrity at all times. I will not lie, cheat, or steal, nor will I accept the actions of those who do."**

Students enrolled in this course are responsible for abiding by the Honor Code. A student who has doubts about how the Honor Code applies to any assignment is responsible for obtaining specific guidance from the course instructor before submitting the assignment for evaluation. Ignorance of the rules does not exclude any member of the University community from the requirements and expectations of the Honor Code. For additional information about the Honor Code, please visit: www.honorsystem.vt.edu.

The Virginia Tech Honor Code applies to all work in this class, including homework, laboratory reports, and examinations. When written work is submitted for grading, it is implied that the work is the sole effort of the person, or persons, whose name(s) appears on the paper. You may seek help on the principles and applications involved in the major assignments, and you may talk to each other about these principles and applications, but you are not to simply copy the work of another person or allow another person to work a problem for you.

Special Accommodations Statement

If you need adaptations or accommodations because of a disability, if you have emergency medical information to share with me, or if you need special arrangements in case the building must be evacuated, please make an appointment with me within the first two weeks of classes.