CE5312: River mechanics

Lecturer:
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Module discription:

This module introduces the student to basic concepts of open-channel flow. Students will first learn fundamentals of steady open-channel flows, e.g. flow resistance calculation, the concepts of normal and critical flows, gradually varied flow and surface profile calculation. Some artificial flow controls, e.g. sluice gate and weir, will also be introduced to allow students see how basic concepts can be used in engineering applications. The second part of the module focuses on unsteady open-channel flow. Students will first learn the derivation of governing equations, i.e. continuity equation and momentum equation. The method of characteristic for solving the governing equations will be introduced based on a few applications, e.g. dam-breaking problem. Fundamentals of river routing, e.g. kinematic wave, dynamic waves and Muskingum-Cunge method, will be briefly covered. While there will be many chances for students to put their mathematical skills to use in this module, the emphasis is on physical understanding of nature phenomenon and solving actual engineering problems.

Grading policies:

The assessment consists of homework, quiz and final exams, and the weightages are 20% for homework, 30% for quizzes, 10% for a small project and 40% for the final exam.

Homework (20%):

There will be 5 homework assignments. Each assignment will be published on IVLE after a Wednesday lecture and will be due on the next Wednesday's lecture. Hard copies of homework solution should be submitted.

Quizzes (30%):

There will be two in-class quizzes in Week 7 and 13 (subject to change). The quizzes will be open-book and take 1.5 hours.

Project (10%):

Students will conduct a small project (in group of 2-3) on numerical modeling of unsteady open-channel flow. Details to be announced later.

Final (40)%

This is a 2.5-hour and open-book exam.

Reference book:

Chaudhry, M. Hanif (2008), Open-channel flow, Springer, ISBN 9780387301747 (digital version available through NUS library)

Subash C. Jain. (2001), Open Channel Flow, John Wiley & Sons, Inc. ISBN 0-471-35641-7

Syllabus:

Week	Content	Homework
	Part I: Steady Open-Channel Flows	
1	**Module introduction**	
	Topic 1: Uniform steady open-channel flows	
	• *Basic hydraulic formula*	
	• *Flow resistance*	
2	**Topic 1 (cont'd)**	**HW1**
	• *Normal depth and rating curve*	
	• *Energy equation*	
	Topic 2: Rapidly-varying steady open-channel flows	
	• *Energy principle and critical flow*	
	• *Flow over a step*	
	• *Momentum principle*	
3	**Topic 2: (cont'd)**	
	• *Unassisted hydraulic jump*	
	Topic 3: Gradually-varying steady open-channel flows	
	• *Governing equation*	
	• *Surface profiles*	
	• *Determination of surface profiles*	
	• *The two-lake problem*	
4	**Topic 3: (cont'd)**	**HW2**
	• *Determination of surface profiles*	
	• *The two-lake problem*	
5	**Topic 4: Artificial channel control**	
	• *Sluice gate*	
	• *Weir*	
6	**Topic 5: Boundary layers for uniform steady open-channel flows**	**HW3**
	• *Concept of boundary layers*	
	• *Laminar boundary layers*	
	• *Turbulent boundary layers*	
	Part II: Unsteady Open-Channel Flows	
7	**Topic 6: Governing equation for unsteady open-channel flows**	
	In-class Quiz 1	
8	**Topic 7: Modeling unsteady open-channel flows using the method of characteristic**	**Project**
	• *Method of Characteristics*	
	• *Numerical method*	
9	**Topic 8: Simple-wave problems**	
	• *Negative surge*	
	• *Positive surge*	
10	**Topic 8 (cont'd)**	**HW4**
	• *Dam-break problem*	
	• *Sluice-gate problem*	
11	**Topic 9: River routing**	
	• *Level-pool method*	
	• *Muskingum method*	
12	**Topic 9: River routing**	**HW5**
	• *Kinematic-wave routing*	
	• *Diffusion-wave routing*	
	• *Muskingum-Cunge routing*	
13	**In-class Quiz 2**	
	Review	