UNIVERSITY OF MICHIGAN
Department of Civil & Environmental Engineering
Flow in Open Channels - CEE 521
FALL 2010

Instructor: Nik Katopodes
Lecture: T-Th 11:30-1:00, 2305 G.G. Brown
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Web Page: https://ctools.umich.edu

Text: Will be provided

Grading: Homework 30%; Mid-term Exam 30%; Final Exam 40%.

Course Description:

Free-surface flow is the most common flow occurring on planet earth. Ocean waves and currents, storm surges, coastal processes, estuarine flushing and lake circulation are all characterized by the flow of water under the effects of gravity. Tidal and flood waves are simpler to study in well-defined open channels, and so is the flow in all man-made canals for water conveyance and drainage. Overland flow and runoff, wetting and drying of tidal flats and floodplains are also covered by the same physical principles. Finally, a variety of industrial flows, especially those focusing on sustainable production methods, make use of open-channel flow.

CEE 521 considers the fundamental principles that govern one-dimensional flow in open channels, develops the basic conservation laws, and some necessary empirical relations that provide engineering solutions to otherwise intractable problems. Emphasis is placed on simplification of the general equations to create models that are suitable for specific practical applications, and to develop methods of analysis and design that can be scaled to larger problems and general geometric configurations.

Course Rules:

The **Honor Code** is based on integrity, a characteristic that is built into the profession. It is reflected in the original and reliable work of all good engineers. When students accept the Honor Code, they acknowledge that it is dishonorable to receive credit for work which is not the result of their own efforts. **Homework** sets are due at the beginning of the lecture period, one week following assignment. Late homework will be penalized 20% for each day it is overdue. All **exams** will be "closed-book" and will cover both theory and applications. You may use, however, one sheet (two pages) of information that may be helpful in the examination.

COURSE SCHEDULE

Month	Day	Topic
September	7	Review of basic concepts; One-dimensional approximation of flow problems; Pressure and velocity distribution in an open channel.
	9	Steady Flow principles; Hydrostatic pressure distribution; Uniform Flow; Rapidly-varied and gradually-varied flow.
	14	Transition Flow; Flow over a bottom ridge and through a constriction; Alternate depths; Occurrence of critical flow; Flow controls.
	16	Specific energy and specific force diagrams; Significance of the Froude number; Conjugate depths; Hydraulic jump and design of energy dissipators.
	21	Flow Resistance; Surface and form resistance. Laminar, transition and turbulent flow; Boundary-layer theory.
	23	Velocity Distribution in Channel Flow; Laminar sublayer and the law of the wall.
	28	Turbulent flow near smooth and rough walls; The friction factor. Chezy and Gauckler-Kutter equations. The “fabrication” of the Manning n.
	30	Uniform flow; Channel conveyance and design of best channel section.
October	5	Non-uniform flow; mild and steep slopes;
	7	Classification of gradually-varied flow profiles; Backwater, drawdown and tailwater profiles; Transfer of information and control of channel flow.
	12	The discharge and two-lake problems; Lateral inflow and outflow.
	14	Simplified equations of unsteady flow; Zero-Inertia and Kinematic-wave approximations.
	19	**Study Break**
	21	**Mid -Term Exam**

	26	Overland Flow - Kinematic-wave theory.
	28	Kinematic-wave Characteristics; Dynamic hydrology and hydrograph analysis.
November	2	Dynamic-wave characteristics; Domain of dependence and region of influence.
	4	Compatibility conditions; Boundary conditions and propagation of waves and signals.
	9	Simple Waves; Depression and centered Waves; Wave reflection and operation of control structures.
	11	Double Waves; The numerical method of characteristics.
	16	Elevation waves and spontaneous shock formation;
	18	Conservation laws for mass and momentum across a moving hydraulic jump; Hugoniot-Rankine conditions.
	23	Dam-Break Analysis – Dry channel.
	25	**Thanksgiving Holiday**
	30	Dam-Break Analysis – Wet channel.
December	2	Partial opening and closing of sluice gates.
	7	Flood Prediction and Mitigation; Sustainable channel design; Removal of dams and conversion of brownfields to wetlands.
	9	Control of open-channel flow; Adjoint equations and sensitivity waves.
	16	**Final Exam – 1:30-3:30 pm**