

## Spring 2026 - CE 59700 (3-credit): Environmental Fluid Mechanics

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**Course description:** This course integrates theoretical analysis, computational modeling using *OpenFOAM*, and laboratory flume experiments to investigate environmental fluid mechanics. Topics include turbulent flow, surface gravity waves, stratified flows, gravity currents, internal waves, and rotational and density-driven flows. Students will explore the dynamics of natural and engineered systems through a combination of mathematical formulation, numerical simulation, and hands-on experimentation, with applications to coastal, atmospheric, and cryospheric processes.

**Prerequisites:** Familiarity with fluid mechanics is recommended but not required. Familiarity with a programming language (MATLAB, Python, C++, etc) is recommended but not required.

**Tentative course schedule (subject to changes): Mondays 3pm-5:40pm**

Date	3pm-4:15pm (theory)	4:25pm-5:40pm (case study with OpenFOAM solvers)	Homework
Jan12	Overview of EFM	Introduction to OpenFOAM	HW1: Install OpenFOAM
Jan19	MLK Day University Closed		
Jan26	Turbulent flows I	Case study: flow through cylinder & airfoil (RANS, solver: <i> pisoFoam </i> )	
Feb2	Turbulent flows II	Case study: flow through cylinder & airfoil (LES, solver: <i> pisoFoam </i> )	HW2
Feb9	Surface gravity wave	Multiphase modeling via volume of fluid method; Case study: dam break (solver: <i> interFoam </i> )	HW3
Feb16	Stratified flows	Case study: stratified flow over an obstacle (solver: <i> interMixingFoam </i> )	HW4
Feb23	Gravity currents and Intrusions		
Mar2	Laboratory experiment: saltwater dam-break flow and resulting gravity current		HW5
Mar9	Internal gravity waves		
Mar16	Spring break, no class		
Mar23	Laboratory experiment: iceberg capsize-induced mixing & internal waves		HW6
Mar30	Stokes flows	Case study: modeling of ice sheet (solver: <i> nonNewtonianIcoFoam </i> )	Release final project
Apr6	Rotational flows I		
Apr13	No class		

Apr20	Rotational flows II	Guest lecture	
Apr27	Final project presentation		

### Assignments

Assessments	Due	Points
Assignments	6 in total throughout the semester	30
Final project presentation	Apr27	30
Final project written report	May4	40
		Total: 100

### Learning outcomes:

1. Apply fluid mechanics principles to analyze gravity waves, turbulent, stratified, Stokes, and rotational environmental flows.
2. Develop and validate CFD models in OpenFOAM for simulating turbulence, gravity currents, surface waves, and other environmental processes.
3. Assess numerical accuracy, precision, and turbulence modeling choices in CFD applications.
4. Design and conduct flume experiments to observe and quantify flow behavior and compare with theory and simulations.
5. Communicate technical results effectively through written reports and oral project presentations.