Environmental and Water Resources Engineering, and Center for Water and the Environment Seminar Series Presents:

Thursday, March 12th, 2026, 3:30-4:30 pm, ECJ 1.324

Zoom Link: https://utexas.zoom.us/j/84820581097

Predicting Marine Propeller Performance in Non-Uniform Inflow via Viscous-Inviscid Interaction Method

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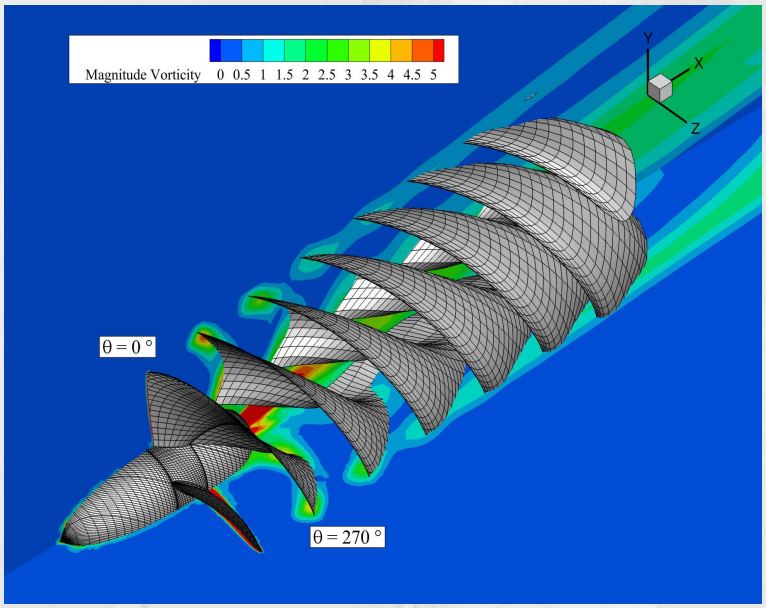

When a ship moves through water, friction between the hull and the surrounding fluid produces a thin velocity-deficit zone called the boundary layer, which determines how much drag the vessel experiences. The same physics applies to the rotating propeller blades, where the problem is more demanding. Each blade passes through a non-uniform flow behind the hull, with the velocity varying continuously during each revolution.

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Reynolds-Averaged Navier-Stokes (RANS) simulations accurately resolve these effects, but their computational cost prohibits routine use in design workflows. Inviscid potential-flow models offer efficiency but cannot capture viscous drag, friction, or trailing-edge pressure recovery. This work introduces an unsteady viscous-inviscid interaction (VII) method that couples a boundary element method (BEM) with an integral boundary layer solver. Viscous effects are incorporated through a wall transpiration model, where a blowing source derived from the boundary layer displacement is applied iteratively to update the inviscid solution.

The method is validated for a marine propeller operating in inclined-shaft flow, a condition that imposes periodic angle-of-attack variations on each blade over one revolution. Predicted surface pressures, skin friction, and boundary layer quantities are compared against unsteady RANS simulations and show strong agreement. The VII method completes the equivalent calculation roughly 40 times faster while using one-quarter of the processing cores, offering a practical tool for rapid, physics-based design iteration.