Ph.D. DISSERTATION DEFENSE

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Title:	Coupled Dynamics and Forcing-Structure Analysis of Floating Wave Energy Converters
Chairperson:	Muhammad R. Hajj, George Meade Bond Professor and Chair, Department of Civil, Environmental and Ocean Engineering
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ABSTRACT

Ocean waves carry an abundant renewable resource, but the most energetic waves occur in deep water, where wave energy converters can no longer be hinged to the seabed and must instead be mounted on moored floating platforms. This dissertation examines two moored converters tested in the Davidson Laboratory wave tank.

In Part I, we investigate the performance of a 1:10 Froude-scale floating oscillating surge wave energy converter. Mounting the flap on a floating platform shifts the resonance from the fixed-flap natural frequency to the first coupled-mode resonance. A three-degree-of-freedom coupled model, validated against boundary-element hydrodynamics, free-decay identification, AQWA-Naut simulations, and tank tests at two wave amplitudes, is used to explain the origin and consequences of this shift. In the floating configuration, the flap is driven primarily by moving-base inertial forcing transmitted through platform surge. Whether this forcing enhances or impedes flap rotation depends strongly on the surge–flap phase. Guided by this result, a passive particle damper is shown to act as a phase shifter, recovering a broadband gain of about 29% in the transition band while reducing platform motion and mooring loads.

In Part II, we investigate the potential for converting wave energy with a 1:8.5 Froude-scale horizontal-pendulum buoy. A governing equation relating the measured buoy motions to the effective forcing on the internal pendulum shows that sustained rotation, the most productive regime for energy capture, arises not from resonance but within a finite frequency window where the two-component horizontal forcing vector rotates coherently. Power measurements confirm that capture is tied to this rotational regime, that the power

take-off load could also extract energy and stabilize the response, and that irregular seas reduce capture by degrading the coherence of the forcing.