# PhD Dissertation Defense Announcement
# Mechanical and Aerospace Engineering Department
# University of Texas at Arlington

## INVESTIGATION OF THERMAL PERFORMANCE ENHANCEMENT AND THERMO-MECHANICAL ASSESSMENT OF ITE USING SINGLE-PHASE IMMERSION COOLING TECHNOLOGY


By

**PRATIK V BANSODE**

Thesis Advisor: Prof. Dereje Agonafer


10 AM, Friday, August 11, 2023

WH 425A [Teams link]


### Abstract

Air-cooling remains vital for data center thermal management, but its effectiveness is limited to low-power CPUs. To address escalating power densities, innovative data center operators are turning to immersion cooling for high-power IT gear. Single-phase liquid immersion cooling (Sp-LIC) excels over forced convection air cooling, allowing direct fluid-component contact for enhanced heat dissipation and IT equipment reliability. Sp-LIC cuts capital and energy costs by removing fans and air handler units. The research objectives are into two parts: thermal efficiency and operational efficiency of immersed IT equipment's. The thermal study is further divided into three sections. The first section involves numerical optimization of heat sinks in forced convection within open compute server design when immersed in single-phase fluid. The second section entails an empirical study of heat transfer and pressure loss in aluminum metal foams immersed in dielectric synthetic fluid. The third section details Particle Image Velocimetry (PIV) for fluid flow pattern visualization and measurement. The second part of the research explores immersion cooling's impact on server reliability. Substrate, a key element in electronic packages, affects reliability and failure mechanisms at package and board levels. Using established compatibility tests like ASTM 3455, aligned with Open Compute Project (OCP) guidelines, the research investigates thermal aging effects on substrate cores immersed in dielectric fluids. Aging occurs at 85°C and 125°C with hydrocarbon fluid (EC100), Polyalphaolefin 6 (PAO 6), and ambient air for 720 hours. Changes in complex modulus and glass transition temperature are measured before and after aging.